FINAL REPORT

COOPERATIVE AGREEMENT

BETWEEN

LINCOLN UNIVERSITY

AND
The US Army Research Laboratory (ARL)

CONCERNING

Multi-task Project to Provide Research Support For Human Research and Engineering Goals Identified by the Army

Contract: W911NF-07-2-0053

Recipient Program Manager (RPM)

Dr. James Rooney
DoD Collaborations Coordinator, Lincoln University
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Jefferson City, MO
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Principle Investigators for contract's 5 Task Areas:

Task I:	James Rooney, Administrative Oversight
Task II:	Mara Aruguete, PI, Use of Non-Lethal Weapons In Crowd Control
Task III:	Sunder Balasubramanian, PI, Laser-based Ultrasound Detection of Unexploded Ordinance
Task IV:	Todd Higgins, PI, The Retention Of AN/PSS-14 Operator Skill Following Standard And Abbreviated Training With Comparisons To Robotically-Controlled Operation
Task V:	Ablo Bah, PI, Suicide Prevention in the Army: Developing A Virtual Experience Immersive Learning Simulation and Expanding Current Efforts On Multivariate Analysis of Suicidal Ideation

Report Overview

This contract was awarded to Lincoln University of Missouri with an effective starting date of May 1, 2007 and an initial period of performance of 16 months. The contract was requested extended on two different occasions, with that last extension date being March 31, 2009, the final ending date for the period of performance relating to this contract.

This contract is often referred to as an "umbrella" contract, wherein the contract contains a number of identified Tasks all structured within a single contract. This contract contained Five Task areas: Task I was an administrative task; Task II-V were specific research tasks as referenced on the cover page of this report.

This report's contents are arranged as follows:

1. Cover Page
2. Program Manager's Overview of the Report (Task I)
3. Summary Final Budget Invoice and Budget unspent balance
4. Technical Reports of the Research Tasks (II – V) as compiled by each Task Principal Investigator:

    a. Task II: Mara Aruguete, PI, Use of Non-Lethal Weapons In Crowd Control
    b. Task III: Sunder Balasubramanian, PI, Laser-based Ultrasound Detection of Unexploded Ordinance
    c. Task IV: Todd Higgins, PI, The Retention Of AN/PSS-14 Operator Skill Following Standard And Abbreviated Training With Comparisons To Robotically-Controlled Operation
    d. Task V: Ablo Bah, PI, Suicide Prevention in the Army: Developing A Virtual Experience Immersive Learning Simulation and Expanding Current Efforts On Multivariate Analysis of Suicidal Ideation

The four research tasks listed above were all deemed sufficiently successful to receive a second year of funding for continuation work (currently in progress) by Army Research Laboratory and Leonard Wood Institute. The scope of this work has changed during Year II to parallel changing needs and interests expressed by Army commands. The reports discussing each of these four research tasks funded within this contract follow with specific references to the Tasks findings, deliverables, problems identified, etc.

As expected by Attachment 5, Part 5, of this contract, this final report will be made available to the following individuals and/or offices:

a. Dr. Alan Davison, CAM, Cooperative Agreement Manager
   Chief, Maneuver and Mobility Branch
   Human Research and Engineering Directorate
   Army Research Laboratory
   Fort Leonard Wood, MO 65473

b. Julia Wertley-Rotenberry
CONTRACTING /GRANTS OFFICER
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c. Agreement Administration Office – **Agreement Administrator**
Office of Naval Research ONRRO Chicago
Federal Building Room 380
230 South Dearborn Street
Chicago, IL 60604-1595
Phone (312) 886-5423
FAX: (312) 353-2094
ONR_Chicago@onr.navy.mil

d. Defense Technical Information Center (DTIC)
8725 John J. Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218

Budget Summary Information

The initial award of $1,920,000 million dollars had added to this amount an additional $171, 468 to accommodate DoD requested further work relating to Task V above, so that Instructional support materials for this project's "Beyond The Front" interactive suicide prevention awareness training DVD could be completed. Thus, the total award relating to this contract is $2,091,468.00.

Coincident to the five tasks comprising this contract, all of the $2,091,468.00 was expended and properly accounted for except an unspent balance of $ 3,221.94 or 0.1% of the total contract award made to Lincoln University..

Copies of the final reimbursement invoice request, Standard Form 270 as well as the Final Status Report Form, Standard Form 269A are attached and appear on the pages immediately to follow.

REQUEST FOR ADVANCE OR REIMBURSEMENT

(See instructions on back)

Approved by Office of Management and Budget, No. 80-R0183

Page 1 of 1 PAGES

1. Type of Payment Requested
   a. "X" one, or both boxes
   [ ] ADVANCE
   [X] REIMBURSEMENT
   b. "X" the applicable box
   [X] FINAL [ ] PARTIAL

2. BASIS OF REQUEST
   [X] CASH
   [ ] ACCRUAL

3. FEDERAL SPONSORING AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH THIS REPORT IS SUBMITTED
   US Army Research Laboratory

4. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER ASSIGNED BY FEDERAL AGENCY
   W911NF-07-2-0053

5. PARTIAL PAYMENT REQUEST NUMBER FOR THIS REQUEST
   10

6. EMPLOYER IDENTIFICATION NUMBER
   446001089

7. RECIPIENT'S ACCOUNT NUMBER OR IDENTIFYING NUMBER
   8148

8. PERIOD COVERED BY THIS REQUEST
   FROM (month, day, year): 02/01/09
   TO (month, day, year): 03/31/09

9. RECIPIENT ORGANIZATION
   Name : Lincoln University
   Number and Street : P. O. Box 29
   820 Chastnut Street
   City, State and ZIP Code : VXP982120477
   Jefferson City, MO 65102-0029

10. PAYEE (Where check is to be sent is different than item 9)
   Name :
   Number and Street :
   City, State and ZIP Code :

11. COMPUTATION OF AMOUNT OF REIMBURSEMENTS/ADVANCES REQUESTED

PROGRAMS/FUNCTIONS/ACTIVITIES >		(a)	(b)	(c)	TOTAL
(As of Date)					
a. Total program outlays to date		$	$	$	$ 2,088,246.06
b. Less: Cumulative program income					
c. Net program outlays (Line a minus line b)					$ 2,088,246.06
d. Estimated net cash outlays for advance period					-
e. Total (Sum of lines c & d)					$ 2,088,246.06
f. Non-Federal share of amount on line e					$ -
g. Federal share of amount on line e					$ 2,088,246.06
h. Federal payments previously requested					$ 2,047,674.08
i. Federal share now requested (Line g minus line h)					$ 40,571.98
j. Advances required by month, when requested by Federal grantor agency for use in making prescheduled advances	1st month				
	2nd month				
	3rd month				

12. ALTERNATE COMPUTATION FOR ADVANCES ONLY

a. Estimated Federal cash outlays that will be made during period covered by the advance	$
b. Less: Estimated balance of Federal cash on hand as of beginning of advance period	
c. Amount requested (Line a minus line b)	$

13. CERTIFICATION

I certify that to the best of my knowledge and belief the data above are correct and that all outlays were made in accordance with the grant conditions or other agreement and that payment is due and has not been previously requested.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL

DATE REQUEST SUBMITTED: 6/22/09

TYPED OR PRINTED NAME AND TITLE: Kevin Ihetu, Controller

TELEPHONE (AREA CODE, NUMBER, EXTENSION): 573-681-5071

This space for agency use

FINANCIAL STATUS REPORT

(Short Form)

(Follow instructions on the back.)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned By Federal Agency	OMB Approved No. 0348-0039	Page of
US Army Research Laboratory	W911NF - 07-2-0053		1 | 1 pages

3. Recipient Organization (Name and complete address, including ZIP code)

Lincoln University
P. O. Box 29
820 Chestnut Street
Jefferson City, MO 65102-0029

4. Employer Identification Number	5. Recipient Account Number or Identifying Number	6. Final Report	7. Basis
1446001089	8148	[X] Yes [ ] No	[X] Cash [ ] Accrual

8. Funding/Grant Period (See Instructions) From: (Month, Day, Year)	To: (Month, Day, Year)	9. Period Covered by this Report From: (Month, Day, Year)	To: (Month, Day, Year)
5/1/2007	3/31/2009	5/1/2007	3/31/2009

10. Transactions:	I Previously Reported	II This Period	III Cumulative
a. Total outlays	$ -	$ 2,088,246.06	$ 2,088,246.06
b. Recipient share of outlays	$ -	$ -	$ -
c. Federal share of outlays	$ -	$ 2,088,246.06	$ 2,088,246.06
d. Total unliquidated obligations			$ -
e. Recipient share of unliquidated obligations			$ -
f. Federal share of unliquidated obligations			$ -
g. Total Federal share (Sum of lines c and f)			$ 2,088,246.06
h. Total Federal funds authorized for this funding period			$ 2,091,468.00
i. Unobligated balance of Federal funds (Line h minus line g)			$ 3,221.94

11. INDIRECT EXPENSE	a. TYPE OF RATE (Place "X" in appropriate box) [ ] Provisional [ ] Predetermined [ ] Final [X] Fixed			
	b. Rate	c. Base	d. Total Amount	e. Federal Share
	10%	$1,898,405.47	$189,840.55	$189,840.55

12. REMARKS (Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation.)

13. CERTIFICATION: I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents.

Typed or Printed Name and Title	Telephone (Area code, number and extension)
Kevin Ihetu, Controller	**573-681-5071**
Signature of Authorized Certifying Official	Date Report Submitted
	6/22/09

Task II: Non-Lethal Weapon Use in Crowds

Mara Aruguete, Ph.D.

I. Introduction.

This is the final report of a yearlong subaward project investigating the simulated crowd reaction to non-lethal weapons. The subaward project consisted of three studies. The results of each study are detailed below.

II. Study 1: Pilot Study

A. Introduction

Non-Lethal Weapons (NLWs) are intended to distract, confuse, disorient, or temporarily incapacitate potentially threatening individuals or material. NLWs may be directed at crowds (targeting a large number of individuals simultaneously), individuals (targeting an identified threatening individual), or machinery (rendering a weapon or machine dysfunctional). Non-lethal weapons were developed for military operations in which peacekeeping and reducing civil unrest were goals. Maintaining law and order in such situations often requires the management of crowds who may be involved in protest. Future military operations planners are increasingly calling for the use of non-lethal weapons during combat operations in which the risk of civilian collateral damage is probable (Thomas & Clements, 1998). Non-lethal capabilities augment lethal weapons and therefore increase the flexibility of the tactical team. Using NLWs, the tactical team may apply varying levels of force in an effort to establish protection and compliance, while minimizing fatalities (Global Security.org, 2006).

The purpose of this pilot research is to develop a reliable set of instruments to measure individual reactions to the use of NLWs in crowds. The first step in the research plan was to seek approval from the Lincoln University Institutional Review Board (IRB). Second, we performed a literature review to locate existing survey instruments whose reliability and validity had been established. Third, we developed measures for constructs that we were not able to locate in the literature. Fourth, we constructed scenarios to reflect three types of non-lethal weapon use. Finally, we collected data on 77 participants to measure reactions to weapon use in the scenarios.

The Lincoln University IRB is a board of scientists and laypeople who assemble to judge the ethical status of research performed by Lincoln University personnel. According to Lincoln University Rules and Regulations, any research involving human subjects must be approved by the IRB before data are collected. We submitted the precise plan for data collection in writing to the IRB in June, 2007. The committee evaluated the research and unanimously approved the project later that month (See Appendix A).

Our proposed survey instrument consisted of measures of demographic variables, reactions to scenarios in which non-lethal weapons were used, state hostility, and attitudes regarding the military use of non-lethal weapons. Despite searching all major government and civilian databases, we were unable to locate any published research examining self-reported reactions to non-lethal weapons. However, we were able to locate a State Hostility Scale developed by Lindsay and Anderson (2000). The measure consisted of 35 questions scored on 5-point scale. The scale showed good reliability and validity but was too long for our purposes. Therefore, we chose 10 questions from the

scale eliminating those questions that may have been difficult to understand for some of our participants (e.g., "I feel discontented", "I feel vexed").

The demographic variables were standard (age, gender, ethnicity, socioeconomic status, political orientation) and we assembled these using measures from research we published in the past. We also developed six measures to examine the reactions of participants to scenarios in which non-lethal weapons were used. These reaction measures were as follows: Anger, Anxiety, Aggression, Dispersal, Helping Behavior, and Perception of Seriousness. Each scale contained 3-5 questions. In addition, we developed scales to measure the General Approval of Non-lethal Weapons (8 questions), Attitudes Toward the Domestic use of Non-lethal Weapons (9 questions), and Attitudes Toward the Foreign use of Non-lethal Weapons (9 questions).

With the help of literature detailing current non-lethal weapons use (Misurelli, 2007), we constructed three scenarios involving the use of non-lethal weapons. Scenarios differed by whether the weapon was directed toward an individual, crowd, or machine. The participant was to read the scenario while imagining him or herself in the situation. The individual would then respond with how he or she would react (anxiety, anger, aggression, dispersal, helping behavior, and perception of seriousness) to the weapon use. The challenge in constructing these scenarios was to make them believable so that individuals could realistically imagine themselves in the situations.

Finally, we administered the drafted survey instrument to 77 participants. The main questions addressed by this report are: Are the measures reliable? If not, which questions ought to be added or eliminated in each measure to ensure reliability? Are the scenarios reasonably believable to participants? And, which variables are significantly

correlated? Finally, we calculated some preliminary results from the pilot data. However, caution should be taken when drawing conclusions from these results since they are based on a small sample of participants.

B. Methods

Participants.

Participants were 77 students and faculty at Lincoln University. Participants were surveyed in summer-term Psychology, History, Political Science, and Mathematics classes. In most cases students were offered extra credit points for completing the survey (See Appendix B for survey draft). Students were offered an alternative way of gaining these extra credit points if they did not wish to participate. One student refused to complete the survey for unknown reasons. The resulting sample consisted of 34 males and 43 females (M age = 27, SD = 11.38). There were roughly equal numbers of African American (36) and White (33) participants, in addition to five participants in other ethnic groups. On a scale of 1-9 with 1 being "liberal" and 9 being "conservative", participants were moderate in their political orientation (M = 5.32, SD = 2.16). Self-reported political party affiliation is detailed in Table 1.

Table 1

		Frequency	Percent	Valid Percent
Valid	Republican	11	14.3	15.1
	Democrat	33	42.9	45.2
	Libertarian	4	5.2	5.5
	Independent	21	27.3	28.8
	Other	4	5.2	5.5
	Total	73	94.8	100.0
Missing	System	4	5.2	
Total		77	100.0	

There were three sections of the survey: 1) Demographics, 2) Reactions to Scenarios, and 3) Attitudes Toward Non-lethal Weapons.

The Demographics section contained nine questions about age, gender, ethnicity, political party affiliation, political orientation (scale = 1-9), parents' education level (scale = 1-7), and parents' occupations (scale = 1-8). Parents' education and occupation was used to compute socioeconomic status (SES; Hollinghead, 1975). Since most students have not yet started their careers nor finished their education, we assumed that parental variables were the most accurate indicators of socioeconomic status.

Each participant read three scenarios in which non-lethal weapons were used (See Appendix B). Scenarios differed by whether the non-lethal weapon targeted a crowd, an individual, or a vehicle. Participants were instructed to imagine themselves in these scenarios. For each scenario, participants completed 23 reaction questions (Anger, Anxiety, Aggression, Dispersal, Helping Behavior, and Perception of Seriousness) addressing how they might react in the situation. In addition, for each scenario they were asked to rate the believability that this scenario might occur in real life.

Finally participants were asked to indicate their attitudes toward non-lethal weapons in general (8 questions), their attitudes toward the domestic use of non-lethal weapons (9 questions) and their attitudes toward the foreign use of non-lethal weapons (9 questions). All reaction and attitude questions were scored on 5-point scales (strongly agree = 5, agree = 4, neutral = 3, disagree = 2, strongly disagree = 1).

C. Results

Reliability.

In examining the pilot data, the first questions we addressed concerned the reliability of the measures. Reliability is the extent to which each question on the scale is consistently measuring the same construct. There are a number of tests to establish reliability. We examined inter-item reliability on our measures using Cronbach's alpha. The goal was to establish that each of our measures examined a single, latent construct. When measuring a single, latent construct (e.g., hostility), Cronbach's alpha should be high (>.70). If Cronbach's alpha is low (below .50), the questions on the scale are said to be measuring *more than one* latent construct (e.g., hostility and persistence). Chronbach's alpha of .70 or higher is considered good reliability in most social science research. Therefore, our goal was to achieve approximately .70 or higher alpha on each scale.

Our 10-item short version of Lindsay and Anderson's (2000) State Hostility Scale showed excellent reliability (Cronbach's Alpha = .86).

The initial Cronbach's alpha reliability in each of the Reaction Scales (Anger, Anxiety, Aggression, Dispersal, Helping Behavior, and Perception of Seriousness) is detailed in Table 2.

Table 2.

Reaction Scale	N of Items	Cronbach's Alpha
Anger	4	.81
Anxiety	5	.81
Aggression	4	.65
Dispersal	3	.08
Helping Behavior	3	.66
Perception of Seriousness	3	.62

The Chrobach's alpha reliabilities for the Anger and Anxiety scales were acceptable. However, items would have to be added or removed on the other scales in order to increase the reliability of each scale. We started this process by examining the Cronbach's alpha as we deleted single items from each scale. By deleting items, we were able to increase the reliability of each scale to acceptable levels, with the exception of the Perception of Seriousness scale. The resulting questions and Chronbach's alpha for each scale are shown in Tables 3-8.

Table 3.

Reaction Scale: Anger	Cronbach's Alpha
I would…	
1) Feel angry.	
2) Feel annoyed.	
3) Feel offended.	
4) Feel cooperative. (Reverse scored)	.815

Table 4.

Reaction Scale: Anxiety	Cronbach's Alpha
I would…	
1) Be afraid.	
2) Feel anxiety.	
3) Feel shocked	
4) Be frightened.	.828

Table 5.

Reaction Scale: Aggression	Cronbach's Alpha
I would…	
1) Curse at the military personnel.	
2) Throw objects at military personnel.	
3) Engage with military personnel	.724

Table 6.

Reaction Scale: Dispersal	Cronbach's Alpha
I would…	
1) Run away.	
2) Stay where I am. (Reverse scored)	.690

Table 7.

Reaction Scale: Helping Behavior	Cronbach's Alpha
I would…	
1) Want to help the victims.	
2) Move toward the victims	.785

Table 8.

Reaction Scale: Perception of Seriousness	Cronbach's Alpha
I would…	
1) Take this situation seriously.	

2) Think the situation was safe. (Reverse scored)	
3) Believe that I am in danger.	.622

All reaction scales reached acceptable levels of reliability with the exception of the Perception of Seriousness Scale. Despite experimenting with addition and deletion of questions from the Perception of Seriousness scale, we were unable to remedy the low reliability on this scale. We therefore decided to eliminate this measure on the reaction scales.

Next, we examined the reliability of the three scales used to measure participants' attitudes toward non-lethal weapons. These scales each initially showed excellent reliability as detailed in Table 9.

Table 9.

NLW Scale	N of Items	Cronbach's Alpha
General Attitudes Toward Non-lethal Weapons	8	.805
Attitudes Toward the Domestic use of Non-lethal Weapons	9	.922
Attitudes Toward the Foreign use of Non-lethal Weapons	9	.924

NOTE: See Appendix B for questions included in these scales.

2) Believability.

For each scenario, we asked participants to judge the extent to which they believed that "situations like this are likely to happen during future military engagement". Given the limited knowledge and experience that our participants had with non-lethal weapons use, we did not expect these believability ratings to be particularly high. Mean

scores ranged between "Agree" and "Neutral" on our scale. There was some variation in believability depending on the scenario (See Table 10).

Table 10.

Scenario Type	N	Minimum	Maximum	Believability Mean	S.D.
NLW directed at vehicle	73	1.00	5.00	3.33	.94
NLW directed at crowd	72	1.00	5.00	3.58	.93
NLW directed at individual	74	1.00	5.00	3.72	.88

NOTE: See Appendix B for description of scenarios.

Slight variations in believability may be accounted for by participants' media exposure to NLWs directed toward individuals (e.g., non-lethal projectiles, such as rubber bullets). NLW's directed at crowds of people and vehicles are less likely to be portrayed in the media.

Preliminary Results.

The following results are mostly descriptive statistics generated from the pilot data. These results are based on a relatively small sample. Because of this limitation, inferences about the population of participants should not be drawn on this sample.

Reactions to scenarios involving the use of NLWs. Reactions to the scenarios are detailed in Tables 11-13 (See Appendix B for descriptions of scenarios).

Table 11: NLW Directed at Individual

	N	Minimum	Maximum	Mean	Std. Deviation
Anger	77	1.00	5.00	3.1006	.87195
Helping	72	1.00	5.00	3.4375	1.00680
Aggression	72	1.00	5.00	2.2824	.91014
Anxiety	74	1.00	5.00	3.6334	.89144
Dispersal	77	1.00	5.00	3.2208	.98506

Table 12: NLW Directed at Crowd

	N	Minimum	Maximum	Mean	Std. Deviation
Anger	74	1.00	5.00	3.3446	.89395
Helping	74	1.00	5.00	3.4257	.93882
Aggression	76	1.00	5.00	2.4079	1.01193
Anxiety	74	1.00	5.00	3.5034	.88798
Dispersal	77	1.00	5.00	3.1883	.94256

Table 13: NLW Directed at Vehicle

	N	Minimum	Maximum	Mean	Std. Deviation
Anger	70	1.00	5.00	2.7446	1.02779
Help	73	1.00	5.00	2.5582	.95427
Aggression	74	1.00	5.00	2.1306	.84186
Anxiety	73	1.00	5.00	3.1421	.94770
Dispersal	74	1.00	5.00	2.6250	.79300

Regardless of the type of weapon presented in the scenario, anxiety was the dominant reaction, and aggression was relatively unlikely. The correlations between reaction measures show the extent to which one reaction (e.g., anger) predicts another reaction (e.g., aggression). Correlations between reaction variables are shown in Table 14.

Table 14.

		Anger	Helping	Aggression	Anxiety	Dispersal
Anger	Pearson Correlation	1	.394(**)	.586(**)	.316(**)	.047
	Sig. (2-tailed)	.	.001	.000	.006	.688
	N	77	72	72	74	77
Helping	Pearson Correlation	.394(**)	1	.279(*)	.184	-.225
	Sig. (2-tailed)	.001	.	.022	.130	.057
	N	72	72	67	69	72
Aggression	Pearson Correlation	.586(**)	.279(*)	1	.254(*)	-.058
	Sig. (2-tailed)	.000	.022	.	.036	.629
	N	72	67	72	69	72
Anxiety	Pearson Correlation	.316(**)	.184	.254(*)	1	.395(**)
	Sig. (2-tailed)	.006	.130	.036	.	.001
	N	74	69	69	74	74
Dispersal	Pearson Correlation	.047	-.225	-.058	.395(**)	1
	Sig. (2-tailed)	.688	.057	.629	.001	.
	N	77	72	72	74	77

*p<.05, **p<.01, 2-tailed tests

Some interesting trends emerge from these data: Aggression is significantly related to anger, helping, and anxiety. This means that people who reacted with more aggression were more likely to be angry, anxious, and helpful. By contrast, the only significant predictor of dispersal (running away) was anxiety. Demographic characteristics of participants were not highly predictive of their reactions to scenarios (See Table 15). As we expected, State Hostility predicted the reaction of Aggression. In addition, political conservativism was negatively related to helping behavior meaning that people who identified as more politically liberal were more likely to react with helping those affected by the use of NLWs.

Table 15.

		Age	Conserva-tivism	SES	Hostility
AGE	Pearson Correlation	1	-.215	-.501(**)	.054
	Sig. (2-tailed)	.	.076	.000	.647
	N	76	69	76	75
Conservativism	Pearson Correlation	-.215	1	.139	-.229
	Sig. (2-tailed)	.076	.	.253	.061
	N	69	69	69	68
SES	Pearson Correlation	-.501(**)	.139	1	.039
	Sig. (2-tailed)	.000	.253	.	.737
	N	76	69	77	76
Hostility	Pearson Correlation	.054	-.229	.039	1
	Sig. (2-tailed)	.647	.061	.737	.
	N	75	68	76	76
Anger	Pearson Correlation	-.021	-.084	-.179	.186
	Sig. (2-tailed)	.857	.493	.119	.107
	N	76	69	77	76
Helping	Pearson Correlation	-.004	-.358(**)	-.144	.174
	Sig. (2-tailed)	.976	.003	.228	.146
	N	72	65	72	71
Aggression	Pearson Correlation	-.061	-.126	-.145	.263(*)
	Sig. (2-tailed)	.612	.320	.225	.027
	N	71	64	72	71
Anxiety	Pearson Correlation	-.030	-.128	-.075	-.012
	Sig. (2-tailed)	.804	.300	.523	.922
	N	73	67	74	73
Dispersal	Pearson Correlation	-.139	.054	.115	-.108
	Sig. (2-tailed)	.232	.660	.319	.354
	N	76	69	77	76

*p<.05, **p<.01, 2-tailed tests

Attitudes toward NLWs. In general, participants showed somewhat positive attitudes toward the military use of NLWs in both foreign and domestic situations. Attitude descriptive statistics are shown in Table 16.

Table 16.

	N	Minimum	Maximum	Mean	Std. Deviation
NLW Domestic Use	75	1.00	5.00	3.3407	.90033
NLW Foreign Use	74	1.00	5.00	3.4459	.84988
NLW General	76	1.75	5.00	3.6020	.68304
Valid N (listwise)	74				

Note: Larger numbers indicate greater approval of NLWs. There were no significant ethnic or gender differences in attitudes toward NLWs

Approval of NLW use was significantly negatively correlated with hostility (See Table 17) meaning that people who showed high State Hostility were unlikely to approve of NLWs. Perhaps these individuals preferred the use of lethal weapons to non-lethal weapons.

Table 17

		Age	Political	SES	Hostility
Age	Pearson Correlation	1	-.215	-.501(**)	.054
	Sig. (2-tailed)	.	.076	.000	.647
	N	76	69	76	75
Political	Pearson Correlation	-.215	1	.139	-.229
	Sig. (2-tailed)	.076	.	.253	.061
	N	69	69	69	68
SES	Pearson Correlation	-.501(**)	.139	1	.039
	Sig. (2-tailed)	.000	.253	.	.737
	N	76	69	77	76
Hostility	Pearson Correlation	.054	-.229	.039	1
	Sig. (2-tailed)	.647	.061	.737	.
	N	75	68	76	76
Attitudes toward NLW Domestic Use	Pearson Correlation	.029	-.008	.106	-.240(*)
	Sig. (2-tailed)	.805	.948	.364	.039
	N	74	68	75	74

Attitudes toward NLW Foreign Use	Pearson Correlation	.107	-.030	-.040	-.217
	Sig. (2-tailed)	.367	.811	.733	.065
	N	73	67	74	73
General Attitudes towards NLW use	Pearson Correlation	-.055	.196	.053	-.239(*)
	Sig. (2-tailed)	.638	.110	.649	.039
	N	75	68	76	75

p<.05, **p<.01, 2-tailed tests

D. Discussion

The purpose of this pilot research was to develop a reliable set of instruments to measure individual reactions to the use of NLWs in crowds. The results of the pilot study yielded the information necessary to revise the instrument in order to collect additional data.

Major revisions to the instrument included the deletion of one three-item scale (Perception of Seriousness) and four questions from other scales. The decision to abandon the Perception of Seriousness scale was based on our inability to achieve adequate reliability on various combinations of questions. In addition, we surmised that the construct of Perception of Seriousness was likely related to Anxiety. We already had a reliable measure of Anxiety. This combination of factors led us to delete the questions comprising this scale.

Pilot data showed that participants generally believed that the three scenarios involving non-lethal weapons were plausible. The believability or plausibility of these scenarios is important insofar as it may be difficult to place oneself in a situation that does not appear believable. In order to gauge participants' reactions to the scenarios in a valid manner, participants must be able to realistically imagine themselves in the

scenarios. The basic structure of these scenarios will remain the same for subsequent data collection. Further studies will systematically alter some elements of the scenarios (e.g., whether the military official is foreign or domestic or the size of the crowd).

Preliminary results show that participants' main reaction to scenarios involving NLWs is anxiety. Anxiety appears to be an adaptive response insofar as it is associated with dispersal, or leaving the situation. However, when anxiety is combined with anger, people appear to become less likely to disperse. Finding the appropriate conditions for the use of non-lethal weapons may involve maximizing the anxiety response while minimizing the anger response. Further manipulation of scenarios may indicate under which conditions people are most likely to disperse.

Regardless or age, ethnicity, and other demographic characteristics, participants were generally in favor of both domestic and foreign NLW use. The only participant characteristic associated with attitudes about NLWs was hostility. The more hostility participants felt, the less likely they approved of NLW use. These individuals may see non-lethal weapons as too mild to deter the advances of a crowd.

Over the next year, we will conduct three additional studies using the survey instruments developed in this pilot research. The first study will examine the effects of origin (whether foreign or domestic) and verbal behavior of military personnel on participants' reactions to NLW use. The second study will examine the effects of size and composition of the crowd on participants' reactions to NLW use. Finally, we will examine the differing reactions to various types of non-lethal weapons (those targeting a crowd, an individual or a machine).

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III. Study 2: Individual Response to Three Types of Nonlethal Weapons

A. Abstract

The purpose of this study was to investigate crowd behavioral reactions to three types of nonlethal weapons (NLWs) used by the U.S. military. The methods we used involved providing participants with simulated scenarios involving military use of NLWs, and asking them to predict how they would react. Our results showed variations in response according to weapon type. Results indicated that individuals were unlikely to aggress or disperse, although these reactions were mediated by demographic factors. Our

discussion suggests that future research should expand the study of behavioral reactions in order to better understand the utility of nonlethal weapons use during warfare.

B. Introduction

Nonlethal Weapons (NLWs) are weapons designed to scatter crowds of people or temporarily incapacitate threatening people or machines. NLWs are intended to minimize permanent injury and damage. A well-known example of an NLW is "pepper spray" (Oleoresin Capsicum), which is derived from cayenne peppers. Pepper spray causes inflammation of the eyes and breathing passages, making aggressive behavior unlikely. The effects are generally temporary with permanent physiological damage being statistically rare in comparison to traditional weapons (Haberland, 2006). The U.S. military began using nonlethal weapons during peacekeeping operations in Bosnia and Somalia (Davison, 2006). Maintaining law and order during peacekeeping often meant managing crowds of civilians involved in protest. Nonlethal weapons had the promise of containing or dispersing the crowds while nearly eliminating the threat of civilian injury and death. The need for nonlethal weapons has recently become apparent during combat operations, especially in urban areas (such as Iraqi cities) where civilians are present in large numbers (Thomas & Clements, 1998). Risk of civilian collateral damage is high when military officials are attempting to control crowds using only lethal weapons. The U.S. military and private contractors have made significant advances in the development of nonlethal weapons (Ames, 2003; Komarow, 2005a; White, 2006). However, lack of information regarding the behavioral outcomes associated with the use of nonlethal weapons continues to be a barrier to using the weapons (Bruno, 2007). Our research

explores individual reactions to NLWs in simulated situations in order to better predict how individuals may react to NLW use on the battlefield.

Although considerable testing has been done to establish the physiological effects of nonlethal weapons (Levine & Montgomery, 2002), behavioral effects have been largely untested. The human target response must coincide with the desired military outcome if the weapon is to be considered effective (Joint Non-lethal Weapons Program, 2007). Although most weapons have desirable behavioral outcomes, military officials are often skeptical about whether such outcomes will occur (Center for Army Lessons Learned, 2000; The Future of Crowd Control, 2004). For example, nonlethal projectiles (such as rubber bullets) are often fired from 12-guage shotguns. The goal of firing a nonlethal projectile is to halt aggression or promote dispersal. However, one can envision a scenario in which targets may believe that lethal weapons are being aimed at them and thus may engage their own weapons, thereby increasing aggression (Center for Army Lessons Learned, 2000). Alternatively, the targets may be aware that nonlethal weapons are being used and increase aggression or fail to disperse because they are undeterred by the mild threat. Davison (2006) reports that smoke was once thought to be a viable NLW, as it obscured visibility and made it difficult for organized action. After some experience on the battlefield, however, the use of smoke was abandoned because it impaired the visual capability of military forces as well as the crowd. Moreover, crowds tended to stay in place rather than disperse. These experiences show that testing the behavioral effects of nonlethal weapons is crucial to understanding how they might operate in a battlefield.

The behavioral response to nonlethal weapons will likely vary by the type of weapon. There are three broad classes of NLWs: those directed at 1) crowds (targeting a large number of individuals simultaneously), 2) individuals (targeting an identified threatening individual), and 3) machines (rendering a weapon or machine dysfunctional). Weapons directed at *crowds* are often intended to disperse the crowd or make people flee from the source of the weapon. An example might be the Long Range Acoustic Device (LRAD), an amplification system that sends out a very loud screeching noise (The Future of Crowd Control, 2004). Apparently, it is a deafening, uncomfortable noise. The LRAD is used to flush individuals out of buildings, or to warn small crafts to retreat from a warship. Weapons directed at *individuals* are generally intended to incapacitate a threatening individual or combatant. An example might be the Taser weapon. When used correctly, the Taser should disrupt muscular control, stopping any behavioral response in progress (Marshall, 2007). Finally, NLWs directed at *machines* are intended to disrupt the functioning of the machine. For example, road spikes, when raised, flatten the tires of a vehicle, impeding further travel (Komarow, 2005b). Given the nature of the three groups of NLWs, we would expect to see greatest crowd dispersal when a crowd-directed weapon is used. Since incapacitation is likely, we predict the least aggression when the individual-directed weapon is used. Finally, we expect low levels of dispersal and aggression when the NLW is directed at a machine, since individuals are not directly targeted.

Attributes of the crowd may influence the behavioral response to NLW use. For example, the ages, genders, personality differences, and ethnicities of crowd members may influence the disposition to aggress or disperse in response to NLW use. Given that

aggression has been consistently tied to testosterone levels, and males between the ages of 15-25 have the highest testosterone levels (Kalat, 2007), one hypothesis would be that young men have a greater tendency to aggress in response to NLWs than other groups. Since we were unable to locate any existing literature that compared demographic attributes of targets in relation to behavioral response to nonlethal weapons, we could only speculate as to how attributes such as ethnicity, socioeconomic status, or political orientation might affect response to NLWs. Knowledge of how the composition of the crowd is associated with response to NLWs, would allow military personnel to make informed decisions about when the use of NLWs is appropriate.

The purpose of our research is to investigate individual reactions to the use of NLWs in crowds. The main questions we address are:

Q1: What are the predominant reactions of individuals when an NLW is used?

Q2: Do the crowd's reactions differ when the NLW is directed at an individual, crowd, or machine?

Q3: How do personal characteristics (e.g., age, ethnicity, gender) affect individuals' reactions to the use of NLWs?

C. Methods

Participants were 207 university students (58 males and 148 females) who were surveyed during six Psychology classes and one Plant Physiology class at a small, public, historically Black university. Participants' average age was 21 years old (SD = 5.30). There were 75 African American and 117 White participants, in addition to 13 participants in other ethnic groups. Self-reported political party affiliation showed 40%

of participants identified as Democrat, 30% Republican, 18% Independent, 2% Libertarian, and 10% other affiliation.

There were two sections of the survey: 1) Demographics and 2) Reactions to Scenarios. The Demographics section contained 18 questions about age, gender, ethnicity, political party affiliation, parents' education level (2 questions, scale = 1-7), parents' occupations (2 questions, scale = 1-7), and state hostility (10 questions, scale = 1-5). Parents' education and occupation scores were used to compute socioeconomic status (SES; Hollingshead, 1975). Since most students have not yet started their careers nor finished their education, we assumed that parental variables were the most accurate indicators of socioeconomic status. Data from students who did not report education and occupation of both parents were excluded from the SES calculation (22% of the sample). We excluded these because we were unable to determine the extent to which the missing parent(s) contributed to the participants' socioeconomic status. After removing these participants from the calculation, the remaining sample (n = 161) showed an average SES (M = 38.38, SD = 12.62) in the middle-class range (Hollingshead, 1975). State Hostility was measured using 10 questions from the State Hostility Scale (Lindsay & Anderson, 2000). The original measure consisted of 35 questions. The original scale showed good reliability and validity but was too long for our purposes. The reliability on our 10 questions remained high (Cronbach's alpha= .88).

Three scenarios were presented to each participant in a repeated measures design. Scenarios each described a case of ethnic rivalry (over immigration or other territorial dispute). The participant was instructed to imagine him/herself as being involved in the protest as a crowd member. Scenarios differed by whether the nonlethal weapon targeted

an *individual*, a *crowd*, or a *machine*. One scenario described the use of an NLW in which a specific **Individual** was targeted by rubber bullets. In this scenario, a military officer fires rubber bullets that strike other protesters. The second scenario described the use of an NLW directed at a **Crowd** of people. In this case, the military officer fires a malodorant at the crowd. The malodorant discharges a chemical odor that induces coughing and nausea. The final scenario depicted the use of an NLW directed at a **Machine.** In this case the participant witnesses the military officer using a vehicular entanglement device, which stops a car that is attempting to approach a roadblock. For each scenario, participants completed 15 reaction questions (Anger, *alpha* = .84; Anxiety, *alpha* = .85; Aggression, *alpha* = .82; Dispersal, *alpha* = .67; and Helping Behavior, *alpha* = .70) addressing how they might react in the situation. In addition, for each scenario they were asked to rate the believability that this scenario might occur in real life. Reaction and believability questions were scored on five-point scales.

D. Results

Believability.

For each scenario, we asked participants to judge the extent to which they believed that "situations like this are likely to happen during future military engagement". Given the limited knowledge and experience that our participants had with nonlethal weapons use, we did not expect these believability ratings to be particularly high. Mean scores ranged between "Agree" and "Neutral" on our scale. Repeated measures ANOVA on believability revealed no significant differences between the belicvability of different scenarios.

Q1: What are the predominant reactions of individuals when an NLW is used?

We collapsed data across scenarios to examine how individuals predicted that they would feel and act when placed in scenarios involving the use of NLWs. Of the measured *emotional* reactions, anxiety ($M = 3.39$, $SD = .78$) was the predominant reaction, although anger was also somewhat likely ($M = 3.09$, $SD = .70$). Of the measured *behavioral* reactions, helping ($M = 3.09$, $SD = .76$) and dispersal ($M = 2.98$, $SD = .63$) were the most likely actions, followed by aggression ($M = 2.22$, $SD = .81$).

Q2: Do reactions differ when the NLW is directed at an individual, crowd or machine?

Table 1 compares reactions to the three scenario types. In the Individual NLW scenario, the participant has witnessed a fellow protester being shot with a rubber bullet. The most predominant reaction in this scenario was anxiety, followed by a desire to help the individual that was shot, and a desire to disperse or run away. Anger and aggression were unlikely reactions to the situation. In the Crowd NLW scenario, the participant is present when a malodorant discharges. The most predominant reactions in this scenario were anxiety, desire to help those affected, anger, and a desire to disperse or run away. Likelihood of aggression was low. In the Machine NLW scenario, the participant is waiting in a line of cars when a passing car is stopped by a vehicular entanglement device. Although anxiety was the most predominant reaction to the situation, reactivity was generally low for all measures.

Table 1

Reactions to Individual, Crowd, and Machine Directed NLW Scenarios (N = 207)

	Hypothetical Scenarios						
	Individual		Crowd		Machine		
Dependent Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*
Anxiety	3.67	.90	3.46	.92	3.08	.99	55.22* [a]
Anger	3.12	.94	3.38	.86	2.78	.89	37.26* [a]
Helping behavior	3.35	.97	3.43	.95	2.49	.97	107.97* [b]
Dispersal	3.28	.96	3.25	.85	2.46	.87	45.00* [b]
Aggression	2.24	.97	2.38	.98	2.05	.89	15.26* [b]

*$p < .001$

[a] p's $< .01$ on all post hoc comparisons
[b] Individual differs from Machine, Crowd differs from Machine, p's $< .01$

We used repeated-measures ANOVAs to test whether reaction measures varied across the three scenarios (see Table 1). The reaction of anxiety differed between scenarios, with anxiety being greatest in the Individual NLW scenario, moderate in the Crowd NLW scenario, and low in the Machine NLW scenario. Anger likewise differed between scenarios. Anger was highest during the Crowd NLW scenario, moderate during the Individual NLW scenario, and low during the Machine NLW scenario. Helping behavior, dispersal, and aggression were significantly more likely in the individual and crowd-directed scenarios and less likely in the machine-directed scenario.

Q3: How do personal characteristics affect individuals' reactions to the use of NLWs?

We examined the effects of gender and ethnicity using t-tests. Women were generally more reactive to the scenarios, displaying significantly more anxiety (t = -5.53,

$p < .001$), anger ($t = -2.47$, $p < .01$), helping ($t = -3.64$, $p < .001$), and dispersal ($t = -2.08$, $p < .04$) than men. There were no significant gender differences in likelihood of aggression.

Only two ethnic groups (White and African American) had enough participants to include in the analyses. In comparing these groups, *t*-tests indicated that African Americans were more likely to be angry ($t = -5.98$, $p < .001$), help others ($t = -2.11$, $p < .03$), and show aggression ($t = -2.42$, $p < .02$) than Whites.

Since there were three sizable political party affiliation groups (Democrat, Republican, and Independent), we examined political party differences using a between-subjects ANOVA. ANOVA showed significant differences between the anger levels of the political parties in response to the use of nonlethal weapons, $F_{2, 176} = 10.56$, $p < .001$. Tukey post-hoc comparisons revealed that Democrats showed greater anger ($M = 3.34$, $SD = .66$) than Independents ($M = 3.00$, $SD = .56$) and Republicans ($M = 2.83$, $SD = .71$). Anger did not significantly differ between Republicans and Independents. Other reaction measures (anxiety, helping behavior, dispersal, and aggression) were not associated with political party affiliation.

The remaining personal characteristics (age, hostility, and SES) were continuous measures and were analyzed by correlation with each reaction measure. Older people were less likely to aggress in reaction to scenarios, $r_{204} = -.20$, $p < .01$. Participants who felt more hostile while they were completing the questionnaire were more likely to show aggression in response to the scenarios, $r_{199} = .29$, $p < .01$. SES was not associated with any reaction measure.

E. Discussion

Nonlethal weapons can be effective alternatives to the use of lethal weapons if they operate as manufacturers intend them to operate. The efficacy of nonlethal weapons depends largely upon the behavioral responses produced by the people targeted. In most cases, the desired responses are halting aggression and/or dispersing a crowd. Despite some limitations, our simulated situations indicate how people tend to react to various types of nonlethal weapons. In addition, our study indicated some individual differences in people's reactions based on demographic characteristics.

One fear of using nonlethal weapons is that they might lead to increased violence of crowd members (Center for Army Lessons Learned, 2000). Contrary to this prediction, our data showed that aggression in response to NLWs was low. Aggression was the least common reaction to individually directed, crowd directed, and machine directed scenarios. The reactions of anger, helping, anxiety, and dispersal were all more common than aggression. Although aggression was generally low, younger and more hostile participants were more likely to aggress than older, less hostile participants. African Americans also scored slightly higher than White participants. Thus, the fear that NLW use might incite high levels of violence is unsupported. However, violence is likely to vary somewhat depending on the composition and mood of the crowd.

The goal of some nonlethal weapons is promoting dispersal, or "persuading people that they would much rather be someplace else" (Council on Foreign Relations, 2004, p.21). For example, experience with crowds in the United States has shown that use of CS-2 (tear gas) tends to effectively scatter a crowd (Council on Foreign Relations, 2004). Other nonlethal weapons have been less frequently tested in the field, and studies

focusing on behavioral effects of NLWs are virtually absent in the literature. In our findings, dispersal was a more common response than aggression although the response was not particularly likely. In fact, the most common response to whether a participant would disperse from the situation was 'neutral' meaning that they were unsure. As expected, scenarios in which crowds or individuals were targeted brought about significantly greater dispersal than scenarios in which the vehicle was targeted. Women were also more likely to disperse than men. Our results indicate that nonlethal weapons may fall short of producing high levels of dispersal among crowd members. However, dispersal may be more likely in crowds involving greater numbers of women.

Perhaps the reason why dispersal was so low was because the desire to help people targeted by the nonlethal weapons was relatively high. Helping and dispersal may be incompatible responses if a person fails to disperse because they are remaining in the crowd to help other members of the crowd. However, they may be compatible insofar as people are able to remove the injured from the situation. In our scenarios, people were more likely to help when an NLW targeted a crowd or individual than when it targeted a machine. African Americans and women were also more likely to help after an NLW was used. Further research should investigate the circumstances under which individuals are most likely to stay and help others. In the event that helping impedes the intended effects of the weapon, specific instructions or other techniques might be used to aid the injured, so that helping behavior becomes less necessary.

Our study has four main limitations that could potentially influence the interpretation of our results. First, our study does not capture the diversity of non lethal weapons in existence. There are many different types of nonlethal weapons and,

depending on their unique effects, responses of people exposed to them will probably vary. Second, participants responded to simulated situations and therefore were not personally or emotionally attached. Reactions are likely to be more intense in actual situations compared to simulated situations. Third, our sample may not represent typical crowds. We had more female participants compared to male participants. Also, our sample is uniquely diverse because data were collected from students at a historically Black university. Finally, our design would have been improved if we had randomly ordered the presentation of scenarios. Fatigue or order effects may have accounted for some of the differing reactions to scenarios. Despite these limitations, our findings represent the beginning of an understanding of the behavioral responses one can expect when using nonlethal weapons. Further research should expand the study of behavioral reactions in order to better understand the utility of nonlethal weapons use during warfare.

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Study 3: Public Perception of Nonlethal Weapons

A. Abstract

This study surveyed 199 university students to examine public opinion toward military use of nonlethal weapons (NLWs). Participants showed moderately positive attitudes toward the military use of NLWs in foreign and domestic contexts. Participants generally agreed that NLWs would be an effective way to control crowds. However, they were less likely to agree that NLW use was ethical. Attitudes varied by demographic group, with women and African Americans being less likely to endorse NLWs. The effects of increased military NLW use may include changes in public support for military operations. Results of this research may help to military planners to anticipate such changes.

B. Introduction

Nonlethal weapons (NLWs) are weapons intended to control crowds or incapacitate threatening individuals or machines without causing permanent injury (Lamb, 2003). After successful use of NLWs during peacekeeping operations, the Department of Defense Joint Non-Lethal Weapons Directorate (JNLWD) was established to lead the US military in the identification and development of NLWs for military use (History:

Nonlethal weapons in DOD, 2007). From 2003 to 2004, the budget of the JNLWD doubled to $44 million. This dramatic increase in the budget occurred largely in response to the recognized need for non-lethal capabilities in Iraq, where insurgents and innocent civilians were often commingled during urban conflicts (Council on Foreign Relations, 2004). The increased funds have led to rapid advances in the development of NLWs for military use (Technology, 2007). With the development of new weapons, human effects research followed, focusing on documenting the physiological effects of the weapons on their targets (Technology, 2007). However, public acceptability of many nonlethal weapons has not been adequately studied. Some fear that the use of nonlethal weapons will amplify the so-called "CNN effect" in which the public sees US troops as aggressors equipped with an array of torture devices (Lardner, 2007). Such public perception could ultimately undermine political support for military operations (Livingston, 1997). Therefore, understanding public perception of nonlethal weapons will be important in understanding how the use of nonlethal capabilities may affect modern warfare. Our study examines the public perception of foreign and domestic use of nonlethal weapons.

There are several indications of variation in public support for nonlethal weapons. Some nonlethal weapons have been deemed illegal at local, national, and international levels (Haberland, 2006). For example, the Chemical Weapons Convention (CWC) prohibits using toxic chemicals during warfare; however, many of the same chemicals are permissible for use in domestic law enforcement (Davison, 2007). In 1995, the UN Conventional Weapons Convention selectively outlawed the use of laser weapons that could cause permanent loss of vision (Fidler, 2005). Moreover, acceptability of non-lethal weapons varies from country to country (Haberland, 2006). Support for non-lethal

weapons may differ by the location in which the weapons are used. Domestic military operations are often perceived as less dangerous than foreign military operations (Alexander, 2001). Thus, a wider variety of weapons may be more tolerated in foreign lands. Therefore, Americans may be more supportive of nonlethal weapon use in other countries than in the United States.

The judgment of ethical use of NLWs may influence public opinion. Most agree that nonlethal weapons, when used properly, can save lives and limit civilian casualties (Alexander, 2001). However, organizations such as The Sunshine Project (2007), Amnesty International (2007), and the British Medical Association (Always nonlethal weapons?, 2007) have repeatedly criticized the development and use of NLWs. The criticisms center around two main issues: 1) reports of deaths resulting from NLW use, and 2) the indiscriminant or improper use of NLWs (Robinson, 2005). The unfortunate term "nonlethal" may make it seem as though the weapon has failed if it ever leads to death (Alexander, 2001). For example, Amnesty International reported that over 150 people have died in the United States after being subdued with a stun gun (an electrical NLW) since 2001. The organization recommends that police departments cease using these devices until further research can be completed on potential risks (Amnesty International, 2007). Indiscriminate or unethical use has also been reported, with NLWs being associated with torture. ABC News reported in November 2005, that American soldiers had used electrical NLWs and rubber bullets on Iraqi detainees (Davison, 2006). Furthermore, there are reports that NLWs have been used to extract people from caves so that they could be fired upon with lethal weapons (No such thing as a non-lethal weapon, 2005). Similarly, "nonlethal" chemical agents were applied during

the Vietnam War to make subsequent lethal weapons more effective (Davison, 2006). Reports of death and unethical use may make the public wary of arming soldiers with NLWs.

Public opinion may also be influenced by whether people perceive NLWs to be effective. Some critics (Borin, 2002) argue that nonlethal weapons are too "soft". The argument claims that military use of NLWs will indicate reluctance of troops to inflict injury, which will undermine their authority and lead to little compliance from adversaries. Dupont (2003) argues that controlling the dose of chemical NLWs used on a crowd is very difficult. Therefore, the use of such agents may kill some of the people officials intend to save (via overdose) while failing to incapacitate threatening individuals (because the dose was inadequate). Fein (2004) notes that the M26 Taser has little effect on people insensitive to pain, and could therefore be ineffective against some adversaries. Moreover, many nonlethal weapons must be used at such close range that they are inappropriate for most combat situations (Fein, 2004).

Our study examines perception of non-lethal weapons in a population of university students. We investigate participants' views on nonlethal weapons in general, and we specifically consider whether participants believe that NLWs are ethical and effective. The research was designed to answer the following questions:

Q1: Are participants comfortable with the US military use of NLWs? Does comfort level vary with the type of weapon or demographic characteristics of participants?

Q2: Do participants distinguish between the acceptability of NLW use in the US or foreign countries?

Q3: Do participants feel that NLWs are ethical to use? Do they feel as though NLWs are effective for crowd control? Does the judgment of ethics or effectiveness vary by the demographic characteristics of participants?

C. Methods

Participants were 199 students (55 male and 144 female) who were surveyed during class at a small, public, historically Black university. Participants' average age was 21 years old (*SD* = 4.87). There were 71 African American and 115 White participants (12 participants indicated other ethnic groups). There were roughly equal numbers of participants indicting affiliation with the Democratic (40%) and Republican (31%) parties; 18% identified as Independent, 2% as Libertarian, and 9% did not identify a political affiliation.

There were two sections of the survey: 1) Demographics and 2) Attitudes toward NLWs. The Demographics section contained four questions about age, gender, ethnicity, and political party affiliation.

Attitudes toward NLWs were assessed by measuring *general attitudes* toward NLWs, *attitudes regarding ethics* of NLWs, and *attitudes regarding effectiveness* of NLWs. General attitudes toward nonlethal weapons were measured by asking participants to indicate how comfortable they were with military use of 9 different NLWs. They evaluated each NLW twice: once for how they felt about the weapon's use in the United States (9 questions, *alpha* = .92), and once for how they felt about the weapon's use in other countries (9 questions, *alpha* =.92). The weapons questions formed three subscales defined by the intended target of the weapon: weapons directed at machines (tire spikes, vehicle barrier, *alpha* = .84), weapons directed at individuals ("stun

gun", microwave beam, projectiles, *alpha* = .86), and weapons directed at crowds (barrier coatings, acoustic weapons, malodorants, chemical irritants, *alpha* = .87).

Participants were asked 5 questions indicating their attitudes toward the ethics of using non-lethal weapons (e.g., "the use of nonlethal weapons is unnecessarily cruel", reverse-scored; *alpha* = .79).

Two questions assessed the effectiveness of nonlethal weapons in crowd control (e.g., "Nonlethal weapons are important means of crowd control"; *alpha* = .82). All attitude questions were scored on 5-point scales (strongly agree = 5, agree = 4, neutral = 3, disagree = 2, strongly disagree = 1).

D. Results

The first question asked whether participants were comfortable with the military use of non-lethal weapons. Participants had moderately positive attitudes toward the military use of NLWs ($M = 3.40$, $SD = .71$, on a scale of 1-5). Men ($M = 3.65$, $SD = .76$) were more comfortable with NLWs than women ($M = 3.65$, $SD = .76$), $t(198) = 3.02$, $p < .01$. White participants ($M = 3.63$, $SD = .67$) were also more comfortable than African American participants ($M = 3.06$, $SD = .62$), $t(185) = 5.78$, $p < .001$. Attitudes varied by the intended target of the weapon described, $F(2,384) = 69.68$, $p < .001$. Paired contrasts showed that participants were significantly less comfortable with weapons directed at individuals ($M = 3.02$, $SD = .90$), than those directed at crowds ($M = 3.60$, $SD = .75$), or machines ($M = 3.62$, $SD = .91$, p's $< .001$). There was no significant difference in comfort level with weapons directed at machines or crowds.

Question two asked whether participants distinguished between the acceptability of NLW use in the U.S. and foreign countries. Attitudes toward weapon use in the U.S.

($M = 3.39$, $SD = .72$) and abroad ($M = 3.42$, $SD = .76$) were very similar. A paired samples t-test showed no significant difference, indicating that participants were moderately positive about weapons use in both contexts.

Question three asked whether participants felt that NLWs were ethical and effective for crowd control. Participants generally agreed that NLWs would be effective for crowd control ($M = 3.84$, $SD = .88$), but felt less certain about the ethics of NLW use ($M = 3.20$, $SD = .69$). Men and women did not significantly differ on their ratings of effectiveness and ethics. However, White participants ($M = 4.16$, $SD = .70$) rated NLWs as more effective for crowd control than African American participants ($M = 3.38$, $SD = .94$), $t(187) = 6.55$, $p < .001$. Likewise, White participants ($M = 3.38$, $SD = .72$) rated NLWs as more ethical to use than African American participants ($M = 2.95$, $SD = .59$), $t(186) = 4.27$, $p < .001$.

E. Discussion

Our participants showed generally favorable attitudes toward the military use of nonlethal weapons. However, attitudes toward NLW use were not overwhelmingly positive. When asked their comfort with various weapon types, mean scores ranged between neutral and agree. Attitudes varied somewhat depending on gender and ethnicity of the participants, although no group showed negative attitudes toward NLWs.

Given the alternative of lethal weapons, we were surprised that participants were not more positive about NLWs. Our research did not assess what sources influenced the participants' attitudes. Media reports condemning nonlethal weapons can often be misleading because they frequently lack a proper comparison situation (Alexander, 2007). For example, it might be reported that stun guns cause death (Man dies after

police jolt him with stun gun, 2007), but the question remains: Had the stun gun not been available, would lethal force have been used? Alternatively, might the target have been beaten and sustained permanent or life threatening injuries? Further research should investigate the sources of information that influence public opinion on nonlethal weapons.

Our participants were less comfortable with weapons directed at individuals, than other types of NLWs. It may be that individually directed weapons (such as high-powered microwave weapons) are perceived as causing greater pain, or leading to death in more instances. Our results suggest that public opinion regarding NLWs depends on the specific weapons in use. Weapons directed at vehicles and groups of people may be more readily accepted, whereas individually directed weapons may represent excessive force. Further public opinion research should examine the properties of the weapons that cause variation in public acceptance.

Women and African Americans were less comfortable with NLWs than were men and White participants. From our data, it is impossible to tell whether these demographic variations are specific to NLWs or whether they apply to all weapons. That is, women and African Americans may be less likely to endorse weapons use in general. Qualitative research could address this question and explore the issues associated with these demographic groups. Addressing the concerns about NLWs that are particular to women and African Americans will likely be useful in efforts to increase support for NLWs.

Participants' moderately positive responses to nonlethal weapons suggest that greater use of NLWs during warfare may not enjoy enthusiastic public acceptance. Greater community acceptance of NLWs will probably require the assurance, through

established rules of engagement, that NLWs are only used as alternatives to lethal force. Nonetheless, the potential for misuse may always make the public hesitant to fully endorse NLWs, especially those individually-directed NLWs that are perceived as producing significant pain. Also, media reporting will likely continue to produce skepticism in the community insofar as the deaths produced by non-lethal weapons remain the focus of reporting on NLWs.

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ANNUAL REPORT - 2007
LASER-BASED ULTRASOUND DETECTION OF UNEXPLODED ORDINANCE

Introduction

Photorefractive multiple quantum wells (PRQW) (Nolte and Melloch, 1995; Nolte and Glass, 1990; Nolte and Ralph, 1992) are among the most attractive candidates for laser-based applications. They have the highest dynamic holographic writing sensitivity (Wang and Nolte, 1992) (requiring only 10 μW/cm2 to fully develop the holographic gratings) and the fastest response time (1 μs at 0.1 W/cm^2) of any photorefractive material, with the largest diffraction efficiency per length (producing diffraction efficiencies of many percent through only a micron of material). PRQWs also have the advantage that they are naturally compatible with diode laser sources, because the PRQW structures are cousins to the structure of inexpensive laser diodes.

Photorefractive quantum wells have other specific attributes that give them the edge over other bulk photorefractives for laser-based ultrasound(Lahiri and Nolte, 1998; Balasubramanian and Nolte, 1999; Lahiri, 1998; Nolte, 1995). One can always tune to quadrature in these materials by varying the wavelength. In bulk photorefractive materials, complicated polarization schemes or large applied fields are required. Another important advantage of the PRQWs is their ultra-low light sensitivity. In laser-based ultrasound, the signal reflected or scattered from a target can be very low. As mentioned above, the photorefractive quantum wells require only μW/cm^2 to write a grating to saturation. In addition, the signal-to-noise performance that can be achieved with PRQWs is comparable to or better than the performance in bulk photorefractives. Therefore, the ultra-low light capability is achieved without significant penalty to phase detection.

The added advantage of having a hologram refresh rate of about 100 kHz (depending on the total light intensity incident on the device) makes the system insensitive to low frequency mechanical vibration. This means that the interferometer can be taken into the field without the requirement for mechanical isolation. This allows for a portable interferometric detection unit that can be carried in the field, or a slightly larger unit that can be mated to armored personnel carriers. Each beam diffracts from the hologram and co-propagates in the direction of the other beam. An important feature of dynamic holography is the matching of the wavefronts between the direct and diffracted waves in each of the arms. The matched wavefronts make it possible to detect the ultrasound signal using a large-area detector. This allows one to make portable LBU systems that can be carried out in the field without worrying about mechanical vibration artifacts in the detection.

Anticipated Results:

In the first phase of this project we proposed to achieve the following objectives:

1) *Set up an optical characterization lab to study the photorefractive multiple quantum well.*

This allows all operational parameters like resonance wavelength of the thinfilm, incident light intensity, applied electric field, spectral phase to be ascertained and optimized. This allows for optimal detection of the ultrasound signal.

2) *Build an ultrasound characterization system that can detect and analyze specific ultrasound signals.*

This will involve calibration systems using contact transducers to vibrate mirrors that will be part of an interferometric setup. The ultrasound frequency is thus controlled and the detection electronics and system will be optimized for high signal to noise.

3) *Setup a device fabrication lab to make the photorefractive multiple quantum well.*

The thinfilm itself will be grown commercially based on a specific design. Once the film is obtained from the commercial grower, it will have to be chemically and mechanically processed and electrical contacts will have to be made. This will be done partly in-house and partly outsourced as a service. This fabrication lab will be set up during phases I and II. For the initial calibration of the system, fabricated and functional devices will be obtained on loan from Prof. Ping Yu's lab at the Dept. of Physics, University of Missouri-Columbia.

4) Assemble the interferometer and obtain a laser-based ultrasound signal from a remote test object.

Achieved Results:

1) Optical Characterization of the Photorefractive Multiple Quantum Well

The initial phase of this work consisted of two parts. The first involved the setting up of laser characterization table to optically characterize the GaAs/AlGaAs semiconductor thin-film. This laser characterization table uses a continuous wave(CW) Ti-Sapphire laser system that can be tuned in wavelength along with a lock-in amplifier and an optical chopper to look at the optical response of the PRQW as a function of light wavelength. The data collection is done through computer control using LabView. This will allow one to optimize the light intensity and applied electric field to ensure that the ultrasound detection has a high signal to noise. This allows the PRQW thin-film to be optimized for ultrasound detection. This has been accomplished. Figure 1 shows the schematic to look at absorption as well as electro-absorption in a photorefractive multiple quantum well (PRQW).

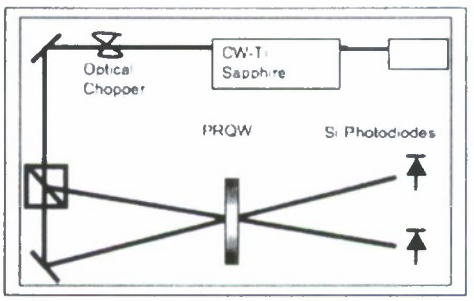

Figure 1: Experimental setup to measure absorption of the PRQW

This laser characterization table uses a continuous wave(CW) Ti-Sapphire laser system that can be tuned in wavelength along with a lock-in amplifier and an optical chopper to look at the optical response of the PRQW as a function of light wavelength. The data collection is done through computer control using LabView. This will allow one to optimize the light intensity and applied electric field to ensure that the ultrasound detection has a high signal to noise. This allows the PRQW thin-film to be optimized for ultrasound detection.

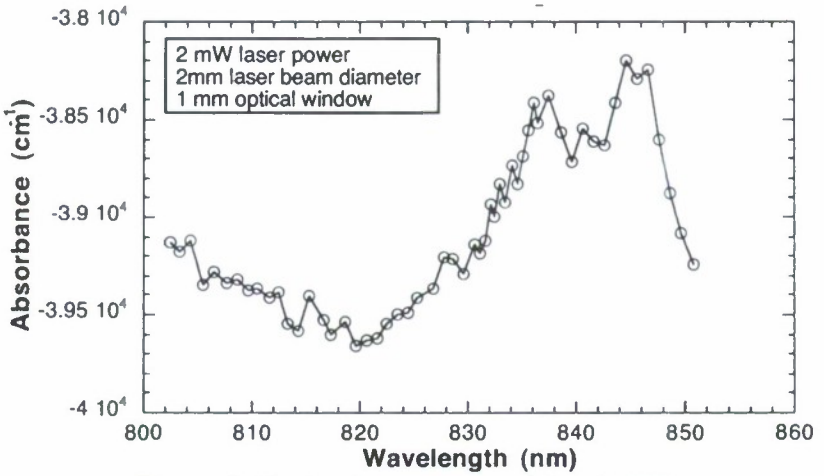

Figure 2: Excitonic resonance of the PRQW

The key aspect that sets photorefractive quantum wells apart from other photorefractive materials, and even from other photorefractive semiconductors, is their ability to draw on interband transitions and on excitonic electro-optic properties (Nolte, 1995). The excitonic resonance is the principal optical resonance in semiconductors. The electro-optic properties are therefore resonantly enhanced, producing both absorption changes and index changes that are several orders-of-magnitude larger than linear nonresonant electro-optic effects. The excitonic effects can be further enhanced through quantum-confinement in quantum wells. The absorption associated with the quantum-confined excitonic transitions is on the order of 10,000 cm^{-1}. Photorefractive quantum well devices therefore need only be on the order of 1 micron thickness to produce maximum diffraction efficiency. This is shown in figure 2.

2) Ultrasound Characterization System

A 300 MHz oscilloscope has been purchased along with a signal amplifier that can amplify signals from DC-350 MHz. The oscilloscope can be controlled by LabView and signals can be aquired real-time. In addition ultrafast detectors (> 125 MHz) have been purchased to detect the ultrasound signal that will be picked up by the optical pickup.

3) PRQW Device Fabrication

The photorefractive thinfilm is grown by molecular beam epitaxy based on a user-supplied design. The device has to be processed before it can be used as an interferometric film. The wafer is first cleaved and a small piece (about 3mm x 3mm) is epoxied to the glass slide with the substrate side up. Then it is mechanically polished and then chemically etched. The chemical etches are done using ammonium hydroxide and hydrogen peroxide. This is followed by a hydrofluoric acid flash and then contacts are deposited on the sample. We have started the setting up of the fabrication lab. The chemicals have been purchased along with suitable glassware. A fume hood will be installed in the coming year and devices will be fabricated on site.

4) Optical Tabletop Interferometer

An interferometer on an optical table has been assembled and is shown in figure 3. This will work in tandem with a nanosecond pulsed-laser system that generates the ultrasound in the 100 MHz to 1 GHz range. The optical interferometer will be using a portable diode laser system as the primary light source. The optical signal, that is a function of the surface vibrations produced

by the ultrasound generated in a test object, will be detected using fast silicon photodiodes, a GHz oscilloscope and a lock-in amplifier detection system. Once the ultrasound signal has been received it can be compared to test signals that will be available in a database. This will allow the material identification of the test object. This is currently being done as a carryover into year two of this project.

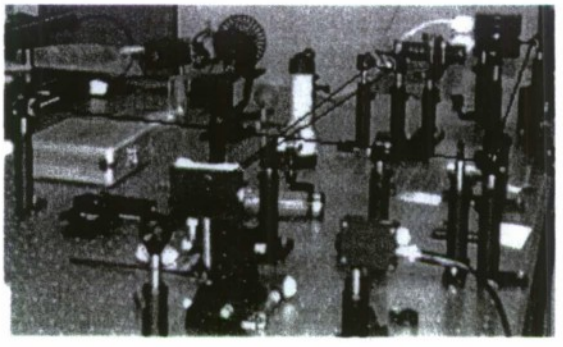

Figure 3: A tabletop interferometer system. The red lines denote the beam path.

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Report of Findings – Standard And Controlled Task IV: The Retention Of AN/PSS-14 Operator Skill Following Abbreviated Training With Comparisons To Robotically-Operation Todd R. Higgins, PI

Summary

This report describes the findings of research conducted on the retention of operator skill in the use of the AN/PSS-14 mine detector when a standard and an abbreviated program of instruction is used to train novice AN/PSS-14 operators. The report also describes the findings of a study of performance in a mine detection task using recently trained AN/PSS-14 operators as compared to a robotically operated mine detection system.

Skill retention in any task tends to decline as time progresses from the last training event. Previous studies conducted by Hancock (2007) demonstrated that AN/PSS-14 operator skill erosion can be detected in as few as 30 days, the decline continued to progress to 90 days; the end of the study period. The purpose of this study was to determine if the length of the initial training period- two, four, or five days - had a significant impact on the rate of skill erosion over time as measured by testing the research participants at various intervals after their initial training – 30, 60, and 90 days post-training – and comparing their performance on the subsequent tests with those of the other training duration groups.

Robotic mine detection achieves the desired end state of removing soldiers from performing most mine detection operations. This study was designed to compare mine detection using a human operator with mine detection performed by a robotically mounted mine detector. Human operators made determinations of the targets under both detection methods. Target detection was enhanced through the use of the robot, and speed of navigating a lane was also enhanced over human detectors.

The final study under this initiative was a sequence of investigations conducted with the intent of gaining understanding of the correlation of the PSS-14 GPR audio alerts associated with anomalous sub-surface dielectric scattering objects illuminated by the GPR radiation field. These studies were conducted from the focal point of what interactions are, or are not, probable and when do the GPR audio alerts occur relative to the occurrence of the maximum intensity of the MD audible alert. Consequently, this study was focused on source-target-receiver configuration geometry.

For the purpose of gaining knowledge of wave-target interactions, a Linear Sweep Facility, that constrains the sweep to a reproducible path, under reproducible dynamic conditions, was constructed, evaluated, and placed into service. MD and GPR alerts were captured in real time by a high resolution, broad-band oscilloscope, along with continuous "sweet spot" position and velocity information.

The primary result of research produced the capture of a GPR length measure from which information concerning the geometry of the target can be gleaned. The possibility of using this measure as a clutter rejection tool is promising.

A secondary result, and perhaps more important from the viewpoint of confidence in the PSS-14, was a chance encounter with the singular condition of transparency of the landmine to GPR radiation. Subsequent tests confirmed the transparency and demonstrated that the PSS-14 essentially works according to primary claims of the manufacturer. These tests were by no means exhaustive, but sufficient to gain confidence in the instrument

AN/PSS-14 Operator Skill Retention Study

Objectives of the Study

- Evaluate AN/PSS-14 operator performance in locating and classifying targets when operator training is conducted on an abbreviated timeline.
- Evaluate AN/PSS-14 operator skill retention at 30-, 60-, and 90-day intervals.
- Determine the effect of training time (3, 4, or 5 days) on AN/PSS-14 operator skill retention.
- Determine if gender influences operator performance.

Methods

Lincoln University established a landmine detection training research facility in 2005 at the university's Carver Farm. The training site is approximately two acres and contains 18 training and testing lanes. Training lanes are 1.5 meters wide by 15 meters long; lanes are divided into ten 1.5m by 1.5m cells. The training lanes are categorized as high or low clutter; clutter being metal objects that are not mine simulants, but can be detected by the AN/PSS-14's metal detector. Placement of targets within a lane and cell was random, with some qualifications – in cells with more than one target, special separation of targets was considered; in some cells the metallic halos of the targets were intentionally made distinct and in others, they were intentionally made to overlap. All lanes have nine simulated mines of various sizes (standard US Army training mine simulants are used). A 15 cm square grid is used to locate targets within each cell; targets are centered on the crossing of horizontal and vertical strings on the grid. Plastic tent stakes position the grid in the same location each time; thus the grid is used for scoring participants' performance in locating targets. Low clutter lanes have 16 pieces of clutter per lane and high clutter lanes have 31 pieces of clutter. The two test lanes are high clutter lanes,

with nine mine simulants and 30 or 31 pieces of clutter per lane. The lanes are periodically swept for indigenous metallic objects by Land Mine Detection Research Center staff using either an AN/PSS-14 or Minelab F-3 metal detector; if found, these metallic objects are removed from the lanes. Staff also periodically check the burial depth and position of targets and adjust targets as necessary.

Research participants (RP) are recruited from Lincoln University and the surrounding high schools. RP's must be 18 years of age to participate in the research, or 17 with parental permission. Interested students must take a modified version of the Armed Services Vocational Aptitude Battery (ASVAB) and score a minimum of 60% to be selected to participate in the program. RPs are paid a stipend for participating; the stipend is split to encourage students to return for the retention testing.

Training in the operation of the AN/PSS-14 is sub-contracted to Battelle. Battelle trainers are former military members who had extensive training in the use of mine detectors while on active duty with the military and who have been trained in the operation of the AN/PSS-14. Battelle conducts an annual instructor training and validation program for its instructors prior to their being assigned to support the research program. A standard 5-day US Army AN/PSS-14 program of instruction (POI) is used as the basis of the training program. LU researchers and Battelle modified the POI to meet the research conditions while ensuring the critical training aspects were covered to enable the RP's receiving the abbreviated training to effectively operate the detector. The POI was abbreviated by removing blocks of instruction on storing the detector, use during fording operations, and practice on target detection was reduced for the 3- and 4-day training groups.

RP's attended training during one of six training weeks; a maximum of nine RPs were

trained on any given week. Participants were randomly assigned to a training duration group and within that group were further assigned to a retention testing group. RP's were instructed on the basics of the AN/PSS-14 system operation during the morning of Day 1, and then began learning to footprint targets during the afternoon. RP's were introduced to mine sweeping on the low clutter lanes and progress to the high clutter lanes. Days 2, 3, and 4 were spent sweeping cells and lanes to build operator skill and confidence in target detection. RP's were given a target detection and identification performance test according to their training duration group; the three-day group was tested on day 3; the four-day group on day 4; and the five-day group on day 5. Test scores for each RP were recorded for later analysis. Regardless of training duration group, no training was conducted on the testing day. Some RP's participated in another study involving operating the detector for approximately 45 minutes per day for two days conducted the week following their testing, normally a Monday and Tuesday. Researchers felt that this additional exposure to the detector would not have a notable effect on the performance of participating RP's in the retention portion of the study.

RP's were then scheduled to return at either 30, 60, or 90 days post initial testing to demonstrate their retention of the skills they developed during the initial training. The retention test was given on the same test lane as the RP took their initial test on. No refresher training was given, nor practice allowed prior to their taking the retention test. Scores were recorded for later analysis.

Participants

Data were collected for 57 RP's with 11 RP's failing to return for re-testing. There were 19 participants in each of the training groups (3-, 4-, and 5-day). With respect to retention groups, there were 18 participants in the 30-day, 13 participants in the 60-day, and 15

participants in the 90-day group. There were 8 females in the study. Data for two RP's (one male and one female) were excluded based on very low proportion of targets found during either qualification test or the re-test. The female participant failed to return for re-testing. Data were also excluded for two participants who initially tested on a different testing lane (A).

As a result, data for 43 RP's, 39 males and 4 females, were examined in the analyses (11 participants did not return for re-test, one additional participant was an outlier, and two more participants initially tested on the lane A).

Overview of Analyses

The univariate analyses of variance were conducted on (1) the total number of targets found, (2) the total number of hits (mine simulants marked with red chips), (3) the total number of hits adjusted to include red and yellow chips placed on mine simulants, (4) the total number of correct rejections (clutter marked with white chips), (4) the total number of false alarms (clutter marked with either red or yellow chips) and (5) the average distance of chip to target.

These variables were examined as a function of test time (Qualification Test vs. Re-test), training duration group (3-, 4-, or 5-day) and retention condition (30-, 60-, or 90-day) with Tukey HSD tests as post hoc analyses. The differences in performance for males compared to females, and whether training week was related to detection performance were also examined. The possible effect of attrition was also examined by comparing performance on the qualification test both with and without the dropout participants.

Results

Total Targets Found. There were no differences in the number of targets found among the groups.

Total Mines Found (Hits). There was a main effect of training group (F (2, 34) = 4.3, $p <$

.05), with the follow-up analyses showing that the 5-day group had more hits than the 3-day group. The 4-day group was different from neither of the other groups.

Total Mines Found Adjusted (Hits Adjusted). There was a main effect of training group (F (2, 34) = 3.82, $p < .05$), with the follow-up analyses showing that the 5-day group had more hits adjusted than the 4-day group. The 3-day group was different from neither of the other groups.

Total Correct Clutter Rejections. There was a main effect of retention condition (F (2, 34) = 8.22, $p < .05$), with the follow-up analyses showing that the 60-day condition had more correct clutter rejections than either the 30- or the 90-day conditions.

Total False Alarms. There was a main effect of retention condition (F (2, 34) = 8.17, $p <$ .05), with the follow-up analyses showing that the 60-day condition had fewer false alarms than either the 30- or the 90-day conditions.

Average Distance to Target. There were no main effects or interactions with respect to the average distance of chip to target.

Performance by Females

The overall mean performance of males compared to females is presented in Figure 1. This figure suggests that there may be either very small, or no, differences in performance between qualifying males and females.

Analyzing the data both with and without female participants, and then comparing the pattern of results from these analyses assessed performance by females. Overall, the pattern of results remained the same when females were not included in the analyses, suggesting that the presence of female participants did not affect direction and magnitude of effects. When analyses included males only, false alarms were lower and correct rejections higher for the 60-day

retention group, compared to the 90-day retention group. With the addition of females (which increased the power of the tests), the 60-day group had fewer false alarms and more correct rejections than the other two groups (30- and 90-days).

Relationship between Performance and Training Week

Correlations (using Pearson correlation coefficient) were conducted to examine the relationship between training week and performance on either test or re-test. There was a weak positive correlation between training week and number of hits on the qualification test (R^2_{adj} = 0.07), with the proportion of hits somewhat increasing as the training week increased.

Performance and training week were not correlated for other variables during either qualification test or re-test times.

Attrition

The main effects of retention group show that, across time of test (test or re-test), the retention groups differed in performance. Selective attrition may have contributed to this. Approximately 20% of participants failed to return for testing, with only 2 dropouts from the 90-day group, 5 dropouts from the 60-day group (who may have been weaker performers, but were excluded from the final analyses), and 4 dropouts from the 30-day group.

The univariate one-way analyses of variance were conduced to examine the impact of retention group on performance separately for the two testing times, with the testing time 1 (qualification test) either including or excluding those participants who failed to return for re-testing.

Performance at testing time 1 (qualification test) was consistent whether the dropouts were included or not. The 60-day group had a greater proportion of correct rejections and lower proportion of false alarms than the 90-day group. There were no differences for the proportion of

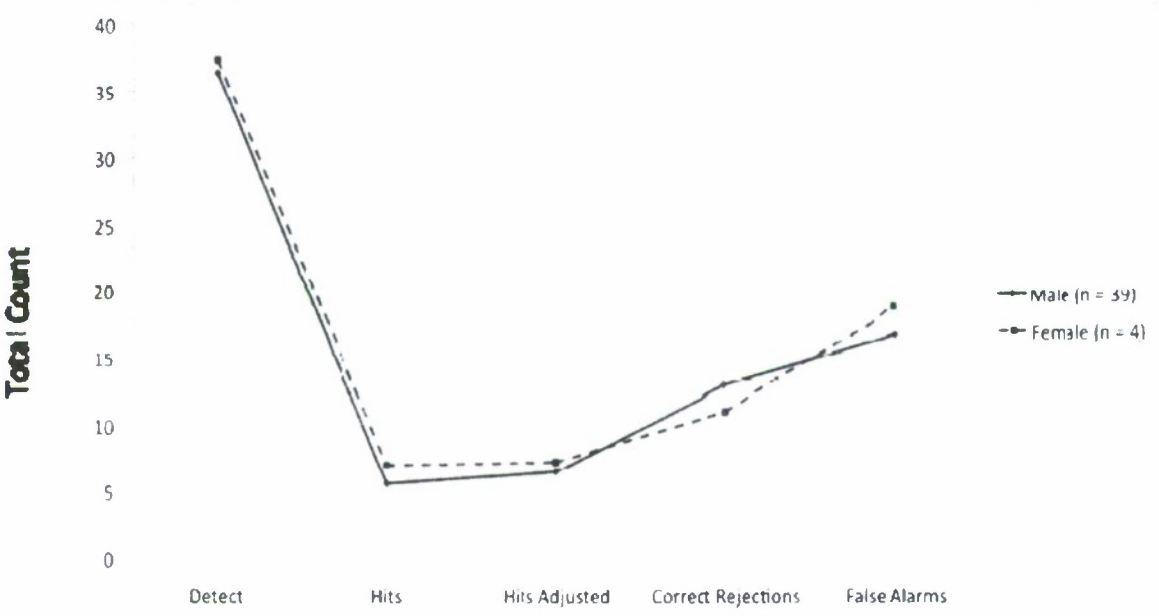
hits, targets found, or mean distance to target.

This pattern of results also occurred when data were analyzed only for test time 2 (re-test).

Rate of change

The 60-day retention group appeared to perform better than the other two groups with respect to correct rejections and false alarms at both testing times. Linear contrasts examined whether the rate of change in performance would differ between the two testing times for the three retention groups. There were no differences in the rate of change.

Figure 1. Comparison of male and female performance.



Discussion

The two variables assessed, training period and retention, showed differences in some comparisons and no differences in others. Training period results will be discussed first, followed by discussion of the retention results.

Training Period

When overall performance was assessed as a function of training period, there was no difference in the total number of targets detected among the three training periods (Table 1) when results for initial testing and retention testing were considered. However, the number of total mines detected did show a significant difference between the 5-day training period and the 3-day training period. Furthermore, there was a consistent decline in total mines detected from the 5-day to the 4-day, and from the 4-day to the 3-day training periods. There was no statistical difference among the training periods for total correct rejections and total false alarms. This suggests that target discrimination improves with more days of training; however it also suggests that the 4-day training period produces operators that are statistically as competent as operators completing training in 4 training days. This finding supports the adoption of a 4-day program of instruction (POI) in support of Reserve Component (RC) AN/PSS-14 certification training.

When an operator cannot determine if the detected target is a mine or clutter and marks the target as a mine it is known as a false alarm. However, if this event is called indecision, it is possible to consider indecision as a function of training period. The effect of indecision is shown in Table 2. Indecision increases as training period decreases. Statistical analysis was not performed on indecision; however it is clear that indecision more than doubles under a 3-day training period when compared to the 4-day training period. Indecision appears to be reduced through additional training days; however, there is little difference between the rate of indecision between the 5-day and 4-day training period. This further suggests that the AN/PSS-14 can be successfully trained to RC soldiers in four days.

The lack of significant variation among male and female operators is encouraging. Researchers did observe some females having physical problems operating the detector for an extended period. The research team observed that some women did not possess the physical stamina in their arms and upper body to operate the detector for an extended period. We do not wish to infer that women should not operate the detector, but rather that our research participants may not have possessed the physical stamina female soldiers possess. It does suggest that there is a physical component to operating the detector and that there may be a need to screen prospective operators for physical strength and stamina when selecting mine detector operators (male or female).

The effect of training week is to be expected and is a function of both the random assignment of research participants to the training weeks and the normal learning curve of the training staff. We also believe that soil environmental conditions can affect target detection; that soil moisture conditions can influence the detection of targets, which influences the test results. We are currently studying the possibility and predictability of this effect under another research contract.

Retention Time

When performance is assessed by time from initial testing to retest (retention period) the 60-day retention group performed best (Table 3) in clutter rejection and false alarms. This is consistent with the group's performance on the initial test. There was a consistent decline in total mines found from 30 to 90 days, although the differences between the means were not significant. Clutter rejection and false alarm results were interesting; the 60-day group being the best in both categories followed by the 30-day group and then the 90-day group. While we expected to see the 90-day group's scores be the lowest among the retention times, we did not expect to see the 60-day group consistently score higher on clutter rejection and false alarms. Although the number of participants in the retention portion of the 60-day group was lower than the other groups, this finding suggests that soldiers can be expected to retain the detection skills gained through their initial certification training for up to 60-days without a significant decline in performance. Operator skills decline rapidly beyond 60 days from initial certification training when no sustainment training is conducted – clutter rejection declines and false alarm rate

increases. This suggests that operator confidence declines and the operator declares targets as mines more frequently. Conducting sustainment training on the system every 30 to 60 days with an emphasis on target discrimination would likely prolong operator proficiency from the perspective of target discrimination. Using a broad range of clutter targets to train operators on during sustainment training might help operators better distinguish clutter targets from mine targets – even if the clutter targets trigger GPR alerts – by imprinting tonal recognition in the operators' brains. In a high clutter minefield, metal detection tonal distinction will likely aid operators locate mine targets and avoid missing small low metallic mines when there is halo overlap caused by clutter.

The reduction in total mines found (Table 3) with time from initial testing is a concern from the perspective of soldier safety. Further analysis of the data is needed to determine if the reduction in mines found is related to specific mine types or is a random occurrence. If a specific type of mine (simulant) is missed more frequently during retention testing, military and humanitarian demining leaders can then ensure that operators spend additional time training on these mine types as part of their sustainment training or pre-mission refresher training. The reduction of total mines found with time from initial testing suggests that GPR short-sweep is a critical skill and an erodible skill. Coupled with GPR short-sweep is the need to sustain centering technique. Analysis of types of mines missed will provide insight into the cause of the higher number of mines missed as a function of elapsed time from initial testing event. If a higher number of low metallic anti-personal mines are missed with time, one or both of two causes are likely – poor centering/GPR short-sweep techniques or poor target tonal discrimination. A supplemental report will be written once these analyses have been performed. We also must consider that operator fatigue becomes an issue; if the analyses indicate that the majority of the missed targets occur in the later cells of the lane (i.e. cells 7-10), then fatigue becomes a plausible explanation.

Recommendations

- The minimum length of the initial operator training course should be no less than four days – three days of training followed by one day of testing.
- Sustainment training on the AN/PSS-14 should be conducted at intervals no longer than 60 days.
- Clutter rejection should be emphasized during sustainment training and the use of a many types of clutter targets should be included in the sustainment training to maximize operator exposure to clutter signals.
- GPR short-sweep technique should be emphasized during sustainment training.
- Sustainment training should include overlapping halos to challenge operators and cause them to focus on target discrimination.

- Consider implementing a test of strength/stamina for prospective operators. If a test is impractical, consider issuing guidelines on strength/stamina thresholds recommended for operators.

Conclusions

Operator performance on the initial test improved as training days increased; however, comparisons of operator performance between 4- and 5-days of training did not reveal consistent statistically significant differences. Study of the data strongly suggest that the length of training period influences operator confidence with the AN/PSS-14 and that a reduction in the number of training lanes completed during operator training significantly affects operator performance in terms of decisiveness.

Operator skill retention is strongly influenced by elapsed time from initial testing; with a marked decline in operator performance between 60 and 90 days post test. Thus, sustainment training that focuses the operator on target discrimination and GPR short sweep is recommended every 60 days to reduce the risk of an operator missing mine targets.

Operator indecision increases as time elapses from initial testing; this is to be expected. What is not readily apparent is whether the indecision results from poor centering technique or poor GPR short-sweep technique; or if it is a result of tone recognition memory loss. Further analysis of the data will be performed in an attempt to answer this question.

Table 1 Mean Values for Initial and Retention Target Detection Results Based on Possible Targets by Training Period

Training Period	Total Targets Detected [1]	Total Mines Detected [2]	Total Correct Rejections [3]	Total False Alarms [4]
5 [5]	36.8 a	6.3 a	14.18 a	17.71 a
4	36.5 a	5.38 ab	12.12 a	15.46 a
3	36 a	4.76 b	11.87 a	17.61 a

[1] Total Targets detected at each test out of 39 possible targets.

[2] Total Number of Mines detected at each test out of 8 possible mines.

[3] Total Number of Clutter rejections at each test out of 30 possible clutter targets.

[4] Total Number of Clutter targets marked as mines

[5] Means followed by different letters are statistically different at the 95% confidence level ($P>F \leq 0.05$) by Turkey's HSD test.

Table 2 Effect of Indecision by Training Period

Training Period	A Targets Determined As Possible Mines	B Total Mines Detected (from Table 1)	Indecision (I) I = A-B
5	6.94 a	6.3 a	0.64
4	6.17 b	5.38 ab	0.79
3	6.36 ab	4.76 b	1.60

Table 3 Effects of Time Interval from Initial Test to Retest on Operator Performance

Time Interval (days)	Total Mines Found	Total Rejection of Clutter	Total False Alarms
30	6.08 a	12.50 b	17.14 ab
60	5.50 a	15.08 a	14.51 a
90	4.85 a	10.6 b	19.13 b

Glossary of Variable Labels

TestTime	time of test	1 = qualification test, 2 = re-test
Group	duration of training	1 = 3-day, 2 = 4-day, 3 = 5-day
Retention	retention condition	1 = 30, 2 = 60, 3 = 90 days
Gender	participant gender	1 = male 2 = female
Week	week of training	numbered by week 1-7
Sum(Detect)	total targets found	out of 39
Sum(IDMine)	total hits	out of 9 (or 8 as one of mines was silent for most participants)
Hits_Adj	total hits adjusted to include yellow (as well as red) chips placed on mines	out of 9 (or 8 as one of mines was silent for most participants)
Sum(ClutNoYel)	total correct rejections	out of 30
Sum(FA w Yellow)	total false alarms (including red and yellow chips)	out of 30
Mean(Distance_Numer)	mean distance of chip from target	mean distance from chip to target center

Robotic Mine Detection

Objectives of the Study

- Assess the ability of the research robot and associated software to detect and remotely display targets buried in a mine lane.
- Assess the ability of human operators to correctly distinguish mine targets from clutter targets on a computer screen during robotic sweeping operations.
- Assess the ability of the Minelab F-3 and a Cyterra AN/PSS-14 to adapt to robotic operation.
- Determine the probability of detection of buried targets when comparing human operators sweeping a mine lane to the robot sweeping a mine lane using the same detector

Methods

Edge Robotics, operating under a subcontract, constructed a research robot for Lincoln University under a prior contract. The robot is equipped with an arm that can traverse left to right a minimum of two meters and can move up or down. Additionally, the robot has an onboard CPU, global positioning system, and a wireless connection for data transmission. The software allows the robot to operate in autonomous mode or be manually guided using a radio controlled guidance system; it also transmits data to a Panasonic Toughbook laptop computer where it is displayed on the screen. The computer screen displays the mine lane and "paints" a picture of the target on the screen so that the human operator can declare a target as either mine or clutter. The robot is equipped with a camera system to aid in navigation and investigation of suspected targets or target locations. Edge Robotics developed the signal processing units used in this study that enabled us to convert the signal output from the detectors to a signal that would be compatible with the software enabling the targets to be displayed on the computer screen.

Two detectors were used in this study; in the first iteration of the study a Minelab F-3 was used to validate the robot detection system and software. The Minelab F-3 is a metal detector only and has no ground penetrating radar (GPR). The second iteration of the study a CyTerra AN/PSS-14 was used as the detector and the GPR was used in the study. The results of both trials will be reported on in this report.

Research participants were recruited from among a population of students who had participated in previous studies conducted by the LU Land Mine Detection Research Center and who had demonstrated proficiency in the operation of either the F-3 or AN/PSS-14. Additionally, three professional trainers (two Army NCO's and one Army contractor)

participated in the AN/PSS-14 trial. Student research participants were paid a stipend for their participation. In both trials, students were given a short refresher training course and given the opportunity to conduct some practice sweeping to re-familiarize themselves with the machines. All participants in both trials were then given training on how to operate the robot and to identify targets on the computer screen. Participants would then sweep a lane for record and would operate the robot on a lane for record. The order in which the participants swept lanes, manually or robotically, was randomly assigned and the lanes on which they sweep were randomly assigned. Some participants swept all low clutter lanes, while others swept only high clutter lanes (low clutter consisted of 15 metallic non-mine targets, high clutter consisted of 30 metallic non-mine targets, and each lane contained 9 mine simulants). Targets in the manually swept F-3 lanes were marked with red poker chips – the single metallic sensor of the F-3 prevents operators from discriminating targets as mine or clutter. Targets in manually AN/PSS-14 swept lanes were marked with either a red, white, or yellow poker chip; a red chip signifying a mine, a white chip signifying a piece of clutter, and a yellow chip signifying indecision. Yellow chipped targets that were mines were included in the "Hits Adjusted" scores for the AN/PSS-14 trial. Robot operation with the AN/PS-14 did not have the option of placing yellow chips, so robot "Hits" and "Hits Adjusted" scores and means are identical.

Techniques for locating mines were different between the human operator and the robot. Both the robot and human swept the lane from side to side, however when a human operator located a target, he paused to investigate the target, center the target, and during the AN/PSS-14 trial perform a GPR short sweep. The robot swept the lane in one direction, moved forward approximately 1/3 of the diameter of the detector head, swept in the opposite direction and with the AN/PSS-14, had the GPR operational during the entire sweep; no GPR short sweep was performed.

The F-3 trial was conducted in August 2008 and the AN/PSS-14 was conducted in January 2009, the latter during one of the coldest periods of the winter.

Results and Discussion

In both the F-3 and AN/PSS-14 trials, the mean values of the robot swept lanes were consistently significantly higher (Table 1) than for the manually swept lanes; the exceptions being false alarm rate (FAR), for which lower is better and the robot had a lower FAR than the manually swept lanes, and total targets found in low clutter lanes. The differences in mean values between the robot and the manually swept lanes in the F-3 trial were smaller than in the AN/PSS-14 trial – this was as expected, because the F-3 doesn't allow discrimination between targets and clutter (although experienced operators often distinguish targets based on tonal variations of the metal detector) and the AN/PSS-14 GPR adds a means to distinguish between mines and clutter. The performance of the robot in high clutter lanes during the AN/PSS-14 trial was more impressive. The mean number of hits and adjusted hits by the robot were both substantially (and statistically significantly) higher than the means of the human operators; 8.57

compared to 5.0 hits and 8.57 compared to 5.71 hits adjusted. This strongly suggests that robotic detection in high clutter environments is safer. The effect of weather conditions on the AN/PSS-14 test scores cannot be discounted. The AN/PSS-14 trial took place during two of the coldest days of the winter; a warming tent was used to keep operators warm before and after they manually swept the lanes, but during sweeping they were exposed to the cold and wind. The robot operators were marking targets from a sheltered location, the interior of a heated vehicle. Again, when mine detection must take place during inclement or extreme weather conditions, robotic detection appears to be a safer alternative than manual detection from a human factors perspective.

The relatively high FAR observed in robot operators during the AN/PSS-14 trial is likely due to the duration training they received prior to performing the record test. Participants were given an opportunity to practice marking targets with the robot, but the practice lasted less than an hour per operator. More time spent training in target recognition and discrimination on the computer screen would most likely result in lowering the FAR.

The increased number of hits in the high clutter condition of the F-3 trial may be indicative of improved discrimination of targets when conditions of halo overlap exist. The robot operator is less likely to be fooled by overlapping halos than the manual operator because the overlapping targets are "painted" on the screen of the laptop as individual targets, the metal detection halos visible and the density of GPR alerts indicating the presence of a mine target if one is present.

Recommendations

- Expand the robot versus human testing to additional locations.
- Develop an autonomous target designation system based on signal output. Include operator override to allow for operator review and discrimination.
- Evaluate robot system with the AN/PSS-14 for use as an IED detection system.
- Develop a target marking system for the robot to aid in target neutralization operations
- Develop a more rigorous training program for robot operators.

Conclusions

Our objectives were to evaluate the robot suitability for use in mine detection operations when equipped with either the Minelab F-3 or CyTerra AN/PSS-14 mine detectors when compared to human operators conducting mine detection operations with the same detectors. The results clearly demonstrate superior performance of the robot in virtually all mine detection performance criteria. The robot was especially beneficial in locating targets in a high clutter

environment when detection was taking place under extreme weather conditions. The use of the robot to identify mine targets through GPR appears to be improved over human use of the GPR capability – more studies are needed to confirm this belief.

Table 1. Results of F-3 and AN/PSS-14 Human Operator versus Robot Target Detection Trials

Trial/Scoring Criteria	**Low Clutter Human**	**Low Clutter Robot**	**F Value**	**High Clutter Human**	**High Clutter Robot**	**F Value**
F3 Trial Hits	22.2 b[1]	22.4 a	34.56	35.8 b	36.5 a	34.56
AN/PSS-14 Trial						
Hits	6.25 b	8.25 a	13.89	5.0 b	8.57 a	13.89
Hits Adj	7.75 b	8.25 a	11.83	5.71 b	8.57 a	11.83
FAR	9.75 b	9.0 a	9.521	17.9 b	15.7 a	9.521
Total Targets Found	23.0 a	22.2 b	97.81	34.6 b	36.3 a	97.81
Correct Rejections	4.75 b	5.0 a	9.022	10.9 b	11.6 a	9.022

1 Means within the same clutter condition and scoring criteria followed by different letters are significantly different at the $P<0.01$ level by a one-way t-test.

Investigation of AN/PSS-14 (HSTAMIDS) GPR Wave Field Interactions

With Buried Dielectric Targets

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Linear Sweep Facility (LSF)

A Linear Sweep Facility was constructed for the purpose of restraining the PSS-14 to follow a reproducible dynamic path across a target, thereby providing an investigative platform to evaluate the Land Mine Detector in a stand-alone scenario. This restraint eliminates any motion variations that might be induced by an operator. While this process cannot be duplicated in the field during search operations without a stable robotic platform, it can be used to evaluate the system alone with regard to the question of repeatability. Moreover, in a laboratory environment many observed response characteristics that have generally not been explained beyond speculation can be addressed quantitatively through experimentation.

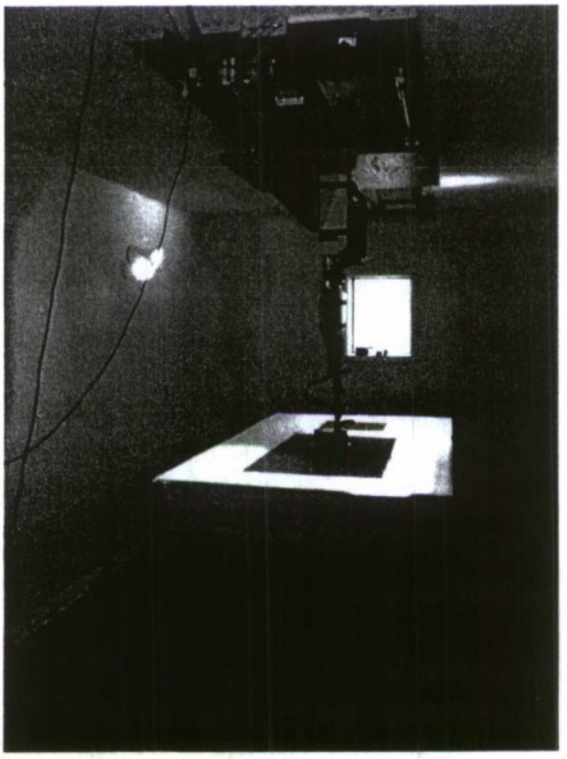


Figure 2. Linear Sweep Translation System;

Figure 1 shows the Linear Sweep Translation System as it was configured in November, 2008. The PSS-14 is shown strapped into a carriage cradle. The carriage is mounted on parallel overhead transport rails and propelled by a belt-driven actuator at speeds up to 3 feet per second. The actuator has a length of 3 meters, and is powered by a user programmable drive that allows for controlled acceleration, constant velocity over the target, and deceleration to a stop position.

The drive also includes an on-board encoder that allows for display of realized acceleration, velocity, and deceleration. Programmable positions are accurate to within 0.0625 cm.

The carriage is also connected to an external wire-line position and velocity transducer, which can be calibrated to all positions along the sweep traverse to within 0.625 cm. By this means the position of the "sweet spot" of the PSS-14, at the time of reception of any reflected or diffracted GPR event, is measurable to within 0.625 cm. Moreover, the velocity of the moving GPR head at any sweep position is also measurable.

The test bed is constructed from Styrofoam blocks and panels. The dielectric constant for Styrofoam is 1.03, as compared to 1.00 for a vacuum. Thus, the test platform is, for all practical purposes, transparent to electromagnetic waves and will not generate any GPR diffractions, or reflections, except where the PSS-14 moves across the top surface contact between the Styrofoam with the earth medium. The surface contains a 4 x 24 x 48 inch well for the placement of a land mine in soil, and a 4 x 16 x 16 inch well for the placement of an electromagnetic receiver beneath a soil cover. This receiver is used for in-situ measurements of the dielectric constant of the material above it. The process of measurement yields depth-dependent dielectricity, moisture content, and electrical resistivity.

Measureable quantities are: MD, GPR, wire-line position, and velocity. Typically, combined MD and GPR are measured, along with wire-line position of the "sweet spot", on a dual channel, 16-bit, 12 GHz PicoScope 9201 PC Oscilloscope. The scope provides real time observation of these measurements. A 24 bit, 96 KHz Edirol WAVE digital recorder was also used to measure MD and GPR data.

Repeatability Tests

The ability of the PSS-14 to replicate a GPR response on successive passes over a land mine simulator has been a major question in the minds of many users of the instrument. Digital recordings of GPR response at the MS&T Circular Sweep Facility (CSF) has led to overwhelming negative conclusions. In fact, an exact replication of anatomical forms measured from successive sweeps over a target at MS&T CSF has never been fully realized. It is a complicated problem involving humans, machines, and algorithmic decision making.

There is a GPR audio packet (GPRAP), consisting of multiple, overlapping, triggered events, activated in a particular zone of the MD response curve. What occurs between the initiation and termination of the packet is not generally repeatable. The individual GPR trigger activity in this zone appears chaotic and untraceable as to origin. However, there is a definitive order that can be observed when viewing the packet as a whole.

Early observations suggested that the beginning of the GPRAP was triggered by a particular character of the increasing MD alert envelope in the initial, rising stage, and turned off by a particular character of the envelope in the terminal, falling stage. But observations established that the form of the MD audio alert has nothing to do with activation, or deactivation, of any GPR event. The on/off "switch" for GPR audio must be controlled by an internal PSS-14 processing algorithm which considers the complex amplitude and phase of the low frequency

induction signal, captured by the MD receiver, and the high frequency wave field captured by the GPR receivers. In fact, it is known that the PSS-14 has a decision making algorithm that considers 100 distinct measured values associated with transmitted and received wave fields: two are associated with the MD measurement, and the rest are associated with GPR measurements. PSS-14 GPR wave fields are distinct frequency, sequential wave packets (as many as one hundred) forming a continuous step-frequency impulse signal that drives the transmitter at a repetition rate of 100 Hz.

The order that is seen when viewing the GPRAP as a whole concerns the length of the packet itself, measured in either units of time or space. This order was observed during a test at the LSF to determine limits of repeatability of the GPR response of the PSS-14. A SIM12 test mine was buried, with the top of the mine covered with 3 cm of relatively dry sand. The PSS-14 transmitter/receiver head was positioned 5 cm above the top of the SIM12 (or 2 cm above the sand surface), and 11 traverses, in both the forward and reverse directions over the buried land mine (22 records), was conducted. A dominant, generally repeatable, character of the observed GPRAP is illustrated in Figure 2.

Figure 2. Illustration of a SIM12 MD+GPR generally repeatable packet signature.

This figure is formed by point-by-point addition, or mix, of two independent oscillating signals corresponding to the MD audio alert and the GPR audio alert:

Figure 3. Illustration of a SIM12, isolated MD audio alert.

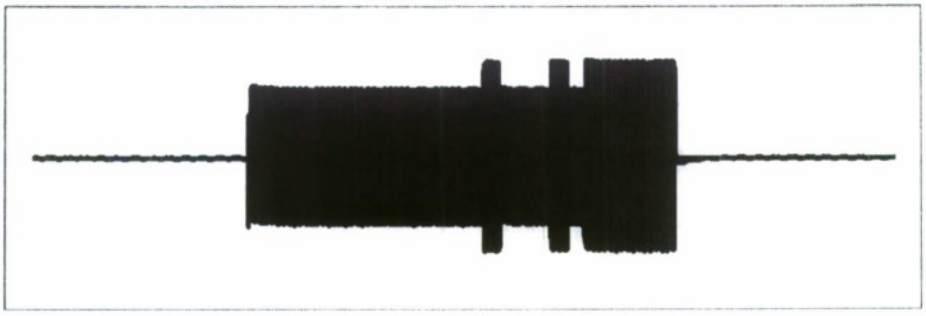


Figure 4. Illustration of a SIM12, isolated GPR audio alert.

The PSS-14 allows the operator to hear, by means of a selectable switch, the isolated MD audio alert; or the isolated GPR audio alert; or the mix of MD and GPR audio alerts. As internally configured, the audio output connector does not support simultaneous recordings of the MD and GPR audio alerts. Thus, the data for Figures 2 through 4 were recorded on three separate passes over the target. While MD data is highly repeatable, GPR data is not. GPR recordings are composed of multiply diffracted or reflected events. In reference to Figure 2, at least nine GPR alerts were issued, while in Figure 4 as many as ten alerts were sounded. Figure A1 of Appendix A examines the anatomy of a typical GPR composite response sequence from multiple GPR triggers.

The jaggedness of the combined MD + GPR audio alerts in Figure 2 is difficult to understand in view of the smoothness of the MD and Audio alerts of Figures 3 and 4, respectively. The obvious cause of this jaggedness is the point-by-point addition process of two signals with slightly different dominant frequencies, resulting in what is known as a beat-frequency response.

Figure 5 illustrates a second recording from the repeatability data set. In the vast majority (82%) of recordings the "generally repeatable packet signature" of Figure 2 can be clearly identified.

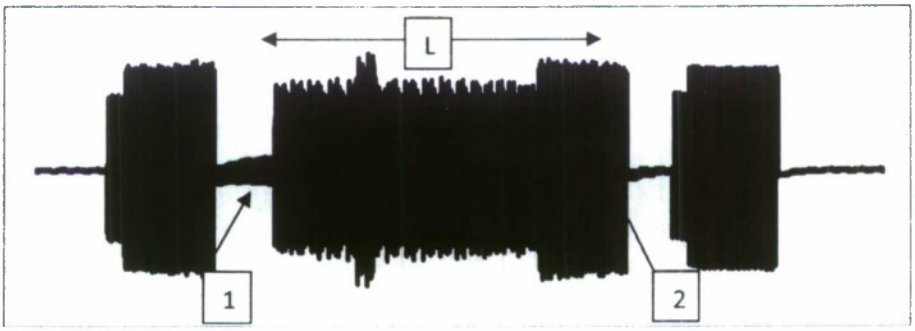


Figure 5. Illustration of common modifications of MD+GPR recordings.

The GPRAP, defined in Figures 2 and 5, exhibit distinct points of initiation [1] and termination [2]. These points occur within the envelope of the active MD audio alert signal. The only significant measurable parameter is the length of the GPRAP, but only if the GPRAP is fully contained within the MD envelope and the MD audio alert is visible before the beginning and after the end of the GPRAP. The only importance to the visual display of the MD audio alert is to recognize the GPRAP from spurious GPR activity on the recording.

Figure 5 also shows near-identical GPR alert signals at the beginning and the end of the record, but they do not occur in the midst of significant MD activity. The form of these near-identical signals has been named the "Fundamental Form", as explained in Figure A2 of Appendix A. A third Fundamental Form can be seen terminating the GPRAP at Point [2] in this figure. The Fundamental Form, without exception, terminates every continuous triggered sequence, and has a length in the neighborhood of .064 seconds. The last GPR trigger in the GPRAP sequence of Figure 5 occurred at the beginning of the terminating Fundamental Form. Therefore, .064 seconds needs to be subtracted from the measured length in order to obtain the time between the issue of initial and terminal triggers. The length of the GPRAP, therefore, is redefined to be the time between the first (initial) trigger event and last (terminal) trigger event in the GPRAP sequence. The subtraction of the duration of the Fundamental Form results in a partial geometrical re-centering of the reduced GPRAP with respect to the MD audio form.

Seemingly-random occurring Fundamental Form events are commonly present in most GPR measurements. The MD signal strength for such occurrences, as can be seen in Figure 5, is generally of the order of background noise. Why they occur is unknown, since their occurrence is suppose to require an active MD alert supposedly above the noise floor. But they do occur, and often obscure the initiation and termination points [1] and/or [2] shown in Figure 5. Such recordings are not usable for measurement of the length of the GPRAP and must be repeated.

The un-obscured initiation point is generally observable (86% of the time), and occurs well up on the slope of the MD curve, just shy of the peak MD value. The reason for this position of occurrence is probably related to the time required to process a single cycle of the step-frequency impulse packet. Transmission of a single cycle requires 10 ms to transmit and 10 ms to receive. The length of the ramp segment prior to the initiation point is of the order of 100 msec. But regardless of why it occurs in this particular window of time, it does 86% of the time, and serves as a benchmark for identifying the beginning of the GPRAP. The MD pigtail at the termination of the Fundamental Form (Point [2] in Figure 5) identifies the appropriate end of the non-reduced GPRAP.

The data illustrated in Figures 2 through 5 were acquired using a PSS-14 running under Version 4.02 Software. Subsequent data is being acquired with a PSS-14 operating under Version 4.03 Software. The only notable difference in performance to date is that Version 4.03

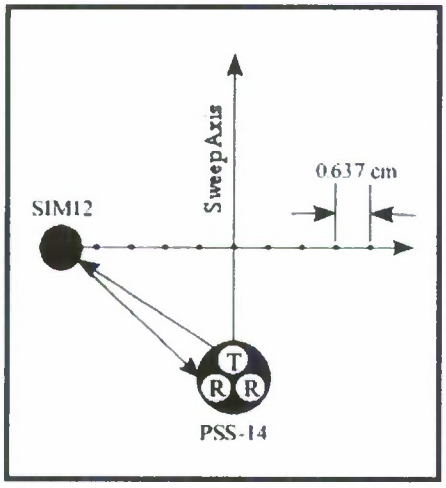
Software produces a significantly different Fundamental Form. This difference is illustrated in Figure A3

LSF Acquisition of GPRAP Data

A SIM12 GPRAP data set was acquired using the linear sweep apparatus. Acquisition geometry is shown in Figure 6. In this figure a SIM12 was offset from the PSS-14 Sweep Axis and GPR data was acquired in a single sweep in only one direction. This procedure was repeated for fifty five SIM12 offsets at space intervals of 0.6357 cm. Because of the requirement of repositioning the land mine accurately fifty five times, the landmine was not buried, but was placed on a defined grid on top of the sand. For each offset, GPRAP data was identified and the measured reduced length (in seconds) was recorded. In Figure 7 the GPRAP length is plotted as a function of SIM12 offset.

In reference to Figure 7, there is a slight corruption of symmetry with respect to the Sweep Axis (0 cm). But the lack of symmetry might be attributed to opposite polarization of the GPR receiving antennas.

The GPR transmitter antenna and the two receiver antennas are all planar spiral antennas, as illustrated in Appendix B. The two receiver antennas have opposite polarity: the co-polar antenna has a spiral winding in the same direction as the transmission antenna, and the quad-polar antenna spirals in the opposite direction. A wave incident upon the air-earth boundary will



Figue 6. GPRAP Acquisition Geometry

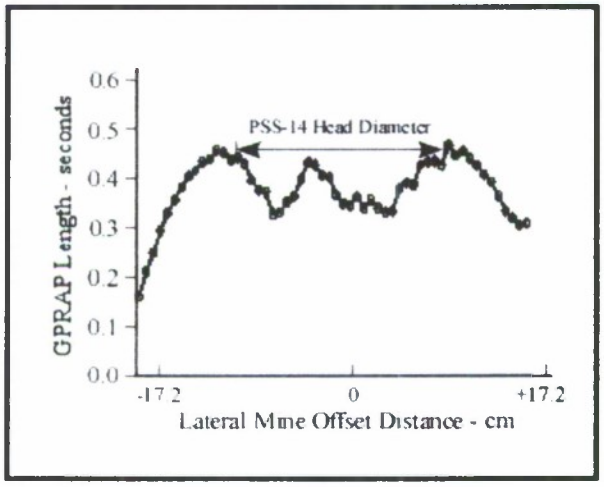


Figure 7. GPRAP length vs. SIM12 Offset

Figure 6. GPRAP acquisition geometry.

Figure 7. GPRAP Length vs. SIM12 offset.

always be reflected with opposite polarity (quad-polarity) relative to the transmitter because the dielectric constant of air is less than that of soil. The quad-polarity antenna can receive the reflection form the air-earth boundary, but the co-polar antenna cannot. When the signal is transmitted across the air-earth boundary and encounters a land mine with a dielectric constant less than that of the soil cover, the reflected event will return to the receiver with the same polarity as the transmitter. The co-polar antenna can receive it, but the other cannot. So there is a measure of non-symmetry in the data because the receivers are displaced 4 cm to opposite sides of the sweep axis of the PSS-14, and the diffraction or reflection events that are returning from the target are being received by the same displaced antenna, having the correct polarity, regardless of which side of the sweep axis the SIM12 is located. So keeping this in mind, let us turn once again to Figure 7.

Since the land mines were not buried, the antenna receiving diffracted and reflected wave events from the land mine would be quad-polar. The symmetry of the data in Figure 7 is shifted to negative lateral mine offset distances, suggesting that the quad-polar antenna is located, in this instance, closest to the mechanical hinge point of the PSS-14 sensor head. This conclusion could be verified by means of an x-ray of the transmission/receiver head. While this discourse seems to be somewhat academic, knowing which receiving antenna was sensing the diffracted and reflected events would allow the sufficiency of measuring offset data on one side of the sweep axis only, thereby reducing the acquisition effort in half.

Understanding GPRAP Length Sections

As an aid to understanding what the data of Figure 7 represents, consider the simple 2-dimensional data acquisition geometry in Figure 8. Figure 8A illustrates the positioning of the SIM12 at an offset position of -17.2 cm. The yellow circle identifies the GPRAP length measured for that offset position. The relative lateral positions of the transmitter and receiver, together with associated ray paths, are also illustrated. It is clear that the illumination of the target can only result in a rim diffraction, which returns to the receiver. The specific point on the rim that produces the highest returning diffraction intensity will occur at a polar angle of the mine where the radius of the mine is coincident with the horizontal component of the illumination field. For any other rim position the diffraction events will be scattered in directions that will progressively diverge from the receiver position as the incident wave field marches around the rim in both directions. Therefore, there is a finite segment of the rim that will produce a relevant diffraction field at the receiver for any source-receiver offset.

The motion of the transmitter along the sweep path causes the relevant rim position to move as well. Since the mine is cylindrical and the sweep path is linear there will be a continual change in the source-target (relevant rim position) distance, which will be interpreted by the PSS-14 as a lateral change in the dielectric constant of the target. Therefore, a continuous stream

of GPR alerts will be triggered as the relevant rim position migrates around the circumference of the mine. But the effective length of migration contributing to the GPR alert (and consequently the GPRAP length) is limited by the transmitter-rim-receiver geometry, and the position of the PSS-14 relative to the MD halo. Thus GPRAPs have a finite length, and GPRAP Length Sections hold the key to discovery of target geometry.

The discourse of the preceding paragraphs also applies for Figures 8B, 8E, and 8F. But for Figures 8C and 8D a reflection process is active.

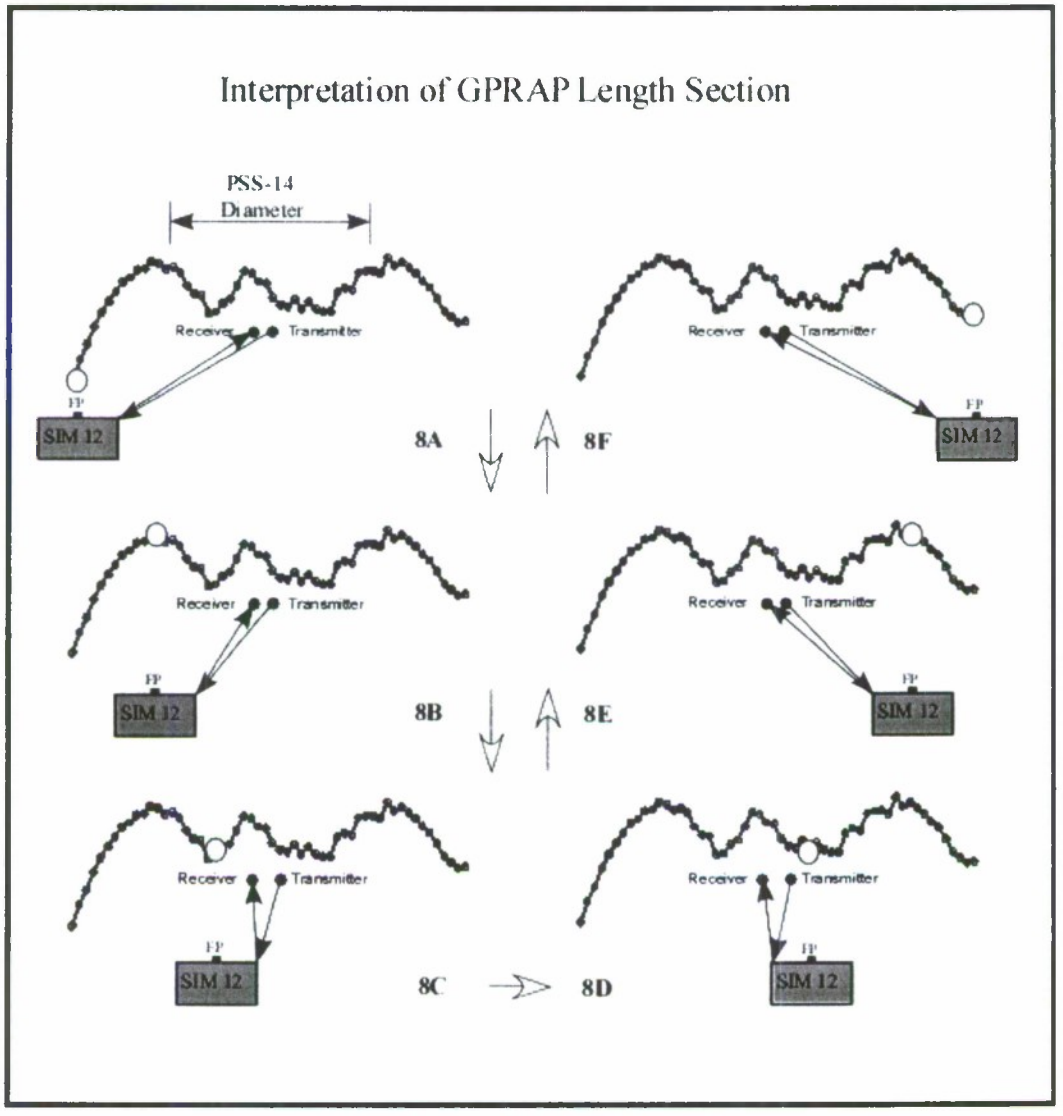


Figure 8. Explanation of GPRAP length as a function of SIM12 offset.

In the central zone, beginning with Figure 8C and ending with 8D, reflections from the relatively flat surface of the SIM12 could dominate. In this region the effective length of the reflection path, traced out by the movement of the overhead PSS-14 along the sweep path, grows from 0 at the circumference of the SIM12 to a full diameter in the middle of the mine as the SIM 12 is incrementally relocated to absolute smaller offset distances. Growth of the reflection path with offset distance results in an extension of time that reflections can be initiated along the path to return to the receiver. As the SIM12 is incrementally moved past the sweep axis, the reflection path length progressively diminishes as SIM12 offset decreases, resulting in a shortening of GPRAP lengths. However, in order to receive any GPR audio alert, a lateral change in the dielectric constant along the sweep path is required. For horizontal, perfectly flat surfaces of a land mine, GPR audio alerts would be expected only from diffractions from the rim. For the SIM 12, which has a relatively flat top, the GPRAP activity over the center of the mine, illustrated in Figure 7, could be due to an existing, raised, dielectric label, bonded to the top surface of the SIM12, slightly offset from the center of the mine.

The GPRAP length is all about diffraction and reflection geometry. GPRAP length is dependent upon the sweep velocity of the PSS-14 over the target, target size, geometry of the top rim of landmine, curvature of the top mine casing, position of the firing pin within the landmine, and position of the MD receiver relative to the extent of the MD halo. Because of the absolute geometric dependence on this process, discrimination between landmines and clutter by means of GPRAP sections might be highly effective.

Addition of a Transverse Step Actuator to the Linear Sweep Apparatus

In order to accommodate precision offset displacements for buried landmines, a transverse actuator was added to the linear transport apparatus of Figure 1. The modified apparatus is shown in Figure 9. This picture illustrates a new, primary carriage riding the pillow blocks of the longitudinal (sweep) rail system, and supporting the transverse actuator and a secondary set of smaller transverse rails. The transverse pillow blocks support the original PSS-14 Carriage as shown in Figure 1. This configuration allows for incremental transverse offsets of the PSS-14 instrument carriage to +/- 30 cm, with position accuracy of 0.05 cm.

To further facilitate offset measurements, the soil bed well was extended to 6 x 30 x 48 inches, and the instrument well was extended to 6 x 16 x 16 inches.

New GPRAP Data Sets for Buried Simulated Land Mines

GPRAP offset data sets were collected for the SIM12 and SIM20 simulated land mines with vertical thin-wall aluminum cylinder simulation firing pins. These firing pins were 8 mm in

diameter and 13 mm in length. The simulators were buried 5 cm beneath the PSS-14 Sensor Head, under 3 cm of sand. The firing pin was at the same depth below the sand for each stimulant. A consistent GPR response was achieved for both SIM12 and SIM20. To our surprise, they were both the same, showing no variation at all in spite of the differences in mine

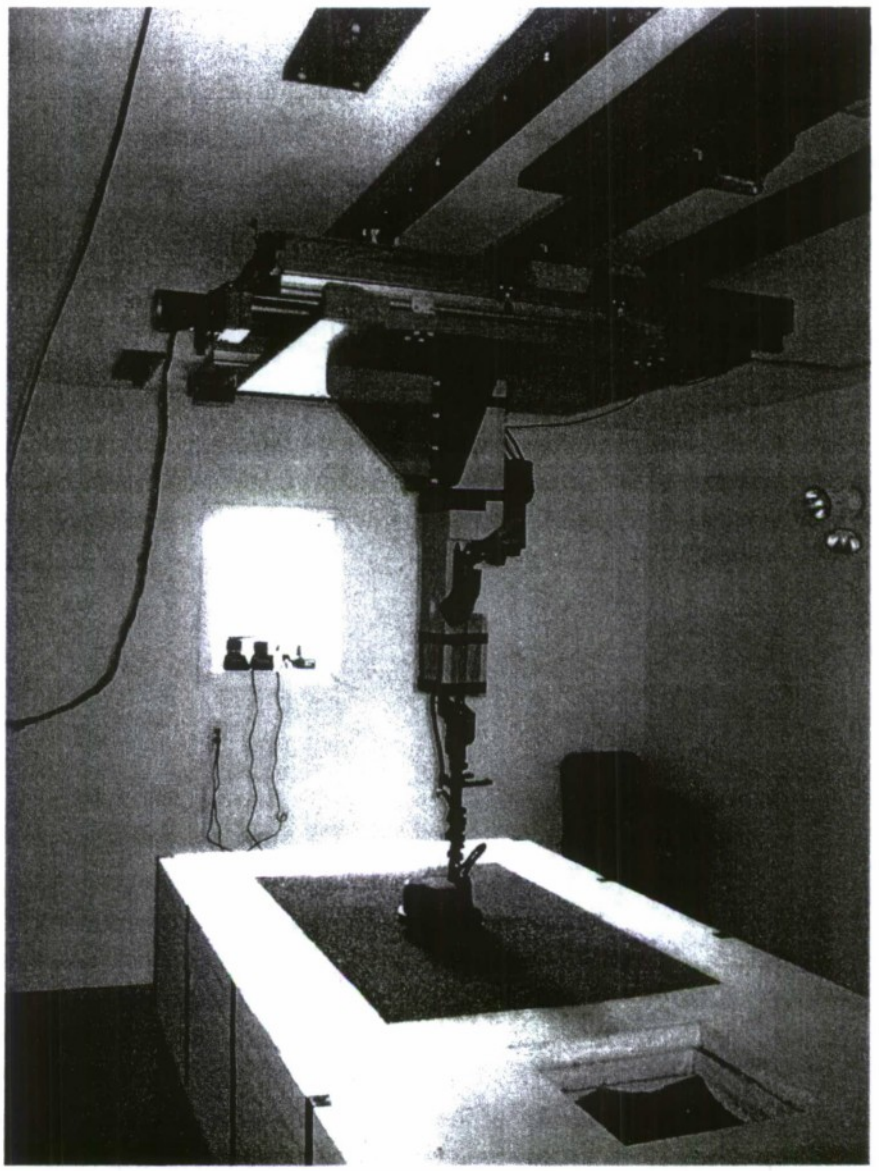


Figure 9. Modified Linear Sweep Translation System

Diameter. There was no correlation to the GPRAP data of Figure 7 whatsoever. In fact, there was no resemblance of the individual GPR events to the "Generally Repeatable Packet Signature" of Figure 2. After much contemplation we buried a spare aluminum firing pin in the

sand at a depth approximately the same as that for the SIM12, and at a safe distance from the SIM12 to eliminate any MD response overlap. We repeated this procedure for the SIM20 as well. The results of our MD and GPR+MD sweeps are shown in Figure 10.

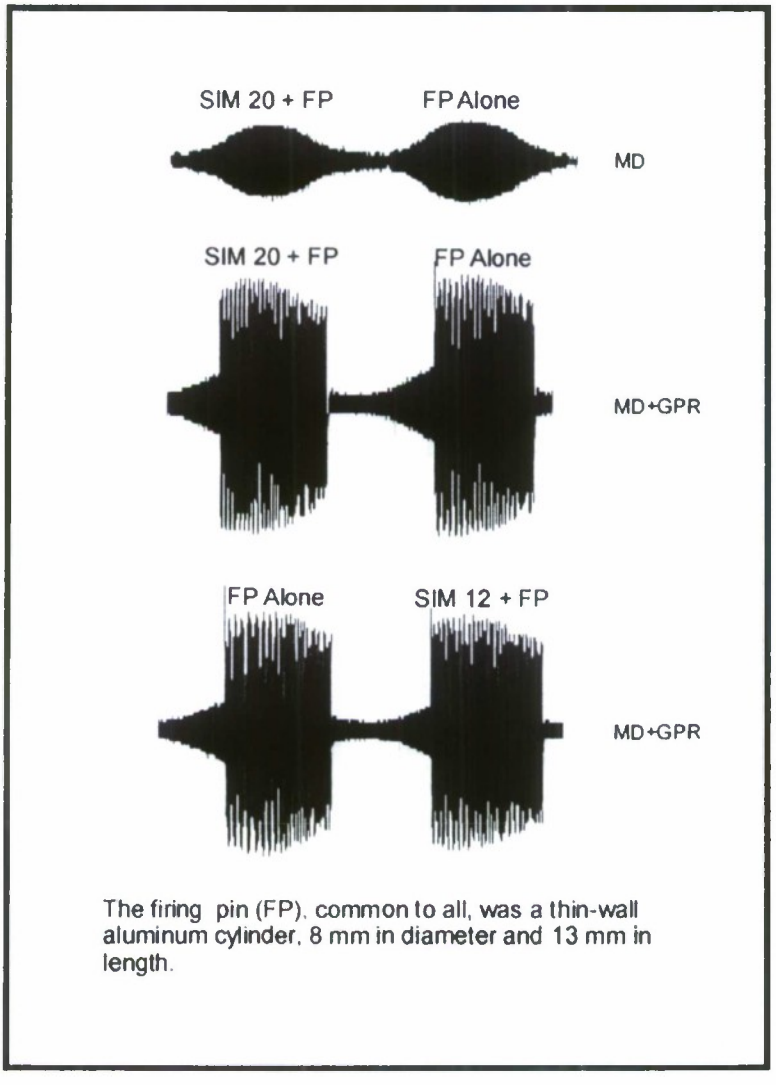


Figure 10. Comparison of GPR response to SIMs and isolated firing pins.

The recorded data of Figure 10 clearly demonstrates that the quantity being recoded is GPR from the firing pin, whether within the SIMs or without. There is a total absence of GPR from the SIM casings. It suggests that the mine casings and the sand have near identical dielectric constants. To test this suggesting we performed the following experiment.

The firing pins were all removed from both the sand and the SIMs. A SIM12 was buried beneath 3 cm of sand and a firing pin was taped to the top of the GPR head, so that the MD alert was constantly triggered. Sweeps over the SIM did not produce any GPR event. The GPR was

incrementally raised to shallower depths to the limit where the top of the mine was even with the top of the sand. Sweeps over the SIM did not produce any GPR event. The mine was raised about 5 mm above the sand level and sweeps over the SIM produced a perfect, repeatable, double GPR event, which I believe is the signature event that we have been seeking for the past 5 years. Figure 11 presents the test configuration and the data.

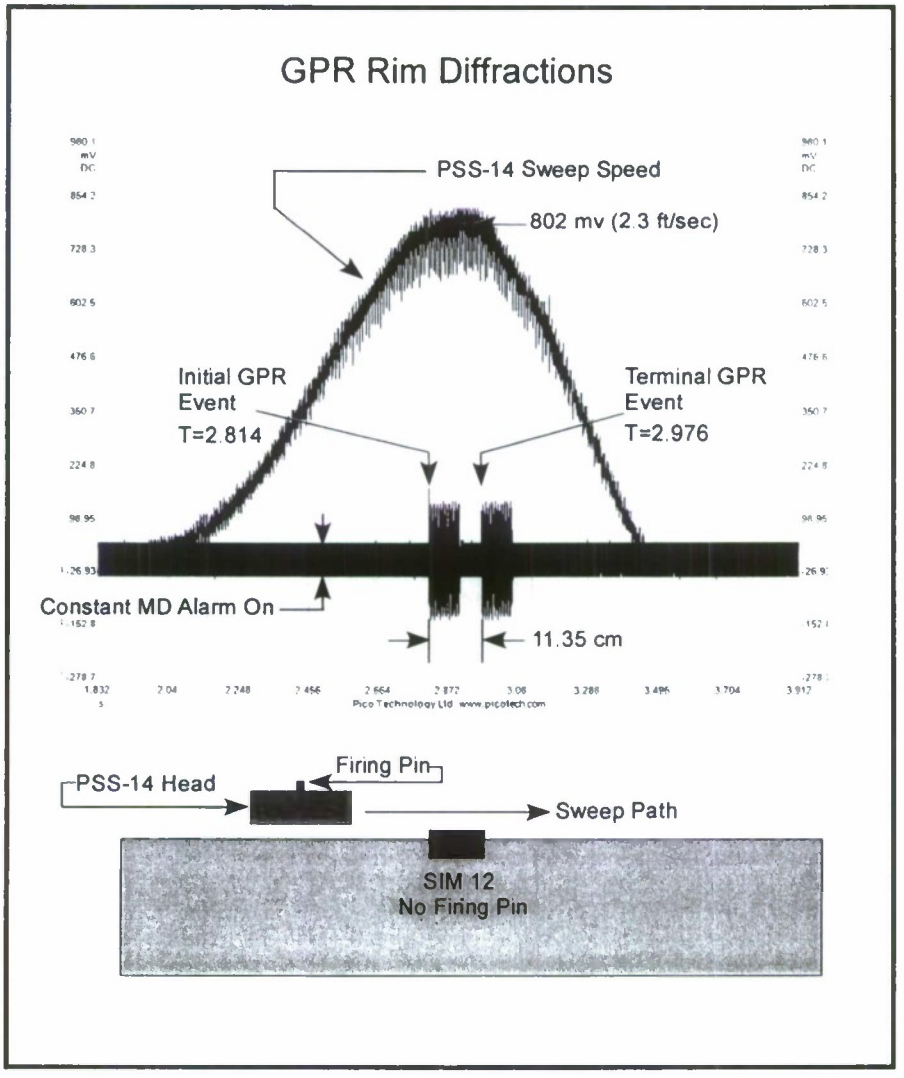


Figure 11. Measurement of GPR from SIM12 casing for constant MD alert.

In this figure the acquisition geometry is shown with the firing pin on top of the PSS-14 transmitter/receiver head, producing a constant GPR alert. The top of the SIM12 is piercing the air/sand interface. For a sweep of the PSS-14 (with firing pin) across the SIM12, two, and only two, GPR events occurred. Each of these events were singular, and of "Fundamental Form". The

measured velocity of the sensing head is shown in red to be approximately 2.3 feet per second over the target. Unfortunately the potentiometer in the position transducer was not working at the time of measurement.

The GPRAP length in time, between the initial and terminal GPR event, is 0.162 seconds. Using the velocity of 2.3 feet per second, the GPRAP length in distance is 13.5 cm, which is the approximate diameter of the SIM12. Therefore, these events are rim diffractions; a conclusion consistent with manufacturer claims. There is an absence of GPR reflections over the flat interior top of the mine, consistent with the claim that a lateral variation of the dielectric constant is required to generate a GPR alarm.

So what happened? The SIM12, buried under 3 cm of sand, was tested for repeatability, as described in a previous section, and we measured authentic GPR response from the surface of the mine. The sand was wet at the time of purchase in early November, 2008, and was placed immediately into the test bed well. But because of hardware problems the tests were not conducted until mid-December. During this time period the heater and dehumidifier in the laboratory was running constantly to protect the computers and other electronic equipment from moisture. The sand must have dried out by the time the repeatability tests were performed, since we measured authentic GPR data. When we made the test bed larger and deeper we had to add 2.5 cubic feet of sand to fill the bed. This sand was wet, and is still a bit moist. And of course, all the new wet sand went on top of the old dry sand. This activity was performed the first week of March 2009, and subsequent measurements over buried targets consistently produced the GPR signature of the firing pin.

So, by removing the firing pin from the SIM and placing it on top of the transmitter/receiver head we forced the GPR to turn on, allowing the lateral change of the dielectric constant between the air and the protruding mine to satisfy the on-board computer logic to produce a GPR alert. When the top of the SIM was below, or even with, the sand surface there wasn't a dielectric contrast to produce a GPR result; evidence of equality of the dielectric constants of the sand and the mine casing. The mine casing behaved like sand, and was transparent to the GPR transmission field. The field passed right through the casing, as if it were sand, into the firing pin chamber where the interaction of the incident transmission field with the firing pin resulted in a diffraction event travelling upward to the receiving antenna. The system actually worked according to principle.

When the sand dries out, and a dielectric contrast is present between the sand and the top of the mine casing, GPR transmission energy will again diffract from the rim of a totally buried casing, causing the issue of a GPR alert. Reflection off the top casing of the SIM shall also resume, but no GPR alerts will be issued unless there is a lateral variation of the dielectric constant in the sweep direction. Little energy should penetrate into the interior of the mine. Thus, the GPR response from the firing pin should be minimized due to loss of transmission energy by reflection from the top of the mine.

The condition of equality between the dielectric constant of the mine and the sand is a singular event in that the observed transparency occurred for only this particular dielectric constant of the sand. The dielectric constant of the sand is determined by the dielectric constant of the soil matrix, porosity, the dielectric constant of the interstitial water, and the degree of saturation. If the sand at target depth was below the state of total saturation, the addition of water might increase the dielectric constant of the local host medium at target depth to a value higher than the dielectric constant of the target. A dielectric contrast would then exist and the target would no longer be transparent.

The top of the mine was located at a sand depth of 3 cm. The condition of the sand at 3 cm might be described as damp, or moist, but certainly not saturated. The addition of more water would, in principle, have rendered the top of the mine visible. So I do believe that the observed transparency was, in fact, a singular event.

Immediate Work Yet to be Performed

System Modification

The longitudinal belt driven actuator requires fine tuning of the motor to the load, which was easy to do for the original, light-weight, longitude-only, translation system. The addition of the 48-inch transverse actuator, plus second carriage and slide rails, resulted in an increased dynamic load of about 150 pounds. This weight increased the primary pillow block friction against the longitudinal transport rail, to the point that the motor could not be properly tuned, and, therefore, was not employed during the limited data acquisition phase conducted in late February and early March. The primary, longitudinal, transport slide was moved by rope and pulley instead.

The 48-inch actuator was an over-kill; a remnant of an earlier vision. The transverse offset system only requires a 16-inch actuator, which would reduce the longitudinal pillow block friction load by more than 40 pounds. All carriage frames can be constructed from aluminum, instead of wood, thus further reducing the weight of the moving system significantly.

Finally, the primary, longitudinal carriage rails need to be precisely aligned with each other and with the longitudinal belt driven actuator. These items need to be permanently mounted on a rigid aluminum frame which will hold the rails and the longitudinal actuator precisely parallel while a longitudinal aluminum carriage, installed on pillow blocks and supporting a 100 pounds test load, moves freely in the shop before being re-installed on the ceiling of the Linear Sweep Facility.

Associated Dielectric Measurement Capability

An LSF capability needs to be established to facilitate measurements of the dielectric constant and magnetic susceptibility of earth materials, as well as mine casings. State of the art equipment is on hand to handle small-grained earth materials, but not mine casings. A non-destructive procedure needs to be developed for determining the dielectric constants of landmine casings. This procedure might be relatively simple.

In view of a previous section dealing with the unsuccessful acquisition of new GPRAP data, due to the SIM12 having the same dielectric constant as the sand, this failure, and the lessons learned can pave the way for a relatively simple procedure for determining the effective dielectric constant of the landmine. The word "effective" is used because dielectric constants are highly frequency dependent, and the frequency content of the PSS-14 transmission field is broadband (0.2 to 2 GHz). The word "effective" will be defined as the bulk dielectric constant that causes the landmine casing to become invisible to the PSS-14.

The Durham Geo Scope Indicator equipment (DGSI) is a time domain reflectivity instrument for soils. We have this instrument on hand. The DGIS measures the speed of an electromagnetic wave through short samples of soil, for various, known moisture contents. The process results in calibration of that particular soil for all time and for all moisture conditions. This calibration would produce a set of soil-specific constants that would be used in future testing of that soil so as to produce the correct dielectric constant, moisture content, and electrical resistivity.

To determine the dielectric constant of any landmine, a reserved volume of soil will be used as a host medium. The size of the soil bed must be large enough to contain the landmine and DGIS equipment, simultaneously, so that the metal content of the DGIS does not interfere with PSS-14 sweeps over the target.

The process would begin with a dielectric calibration of a given soil. The soil moisture content must be relatively low, for it is easier to induce moisture than to dry it.

The landmine will be inserted into the calibrated soil in one of two ways:

(a) If the landmine contains a firing pin, the landmine must be fully buried.

(b) If the landmine does not contain a firing pin, the top of the land mine should be buried slightly below the surface of the soil so that a very light, thin film of soil covers the top of the mine.

The test procedure for determining the dielectric constant of a landmine with a firing pin begins by placing the landmine on top of the soil and performing a normal sweep over the

exposed target. The combined MD + GPR audio alert will be viewed in real time by means of an oscilloscope. The visual GPR response will be that for GPRAP diffractions from opposite rim positions on the landmine. Next, bury the landmine according to (a) above, followed by sweeping the PSS-14 over the mine using normal sweep procedures. View the new combined GPR audio alert. If the same visual representation is displayed, then the soil is too dry. Sprinkle water over the site, wait an appropriate time for the moisture to penetrate to depth and repeat the sweep. Repeat this cycle until the visual combined representation changes to a different form. This form will be the combined MD + GPR response from the firing pin. At this point take a reading with the DGIS. The calculated dielectric constant will be that of the landmine.

The test procedure for determining the dielectric constant of a landmine without a firing pin begins by positioning the land mine and isolated firing pin according to (b) above, followed by sweeping the PSS-14 over the mine using normal sweep procedures with the audio input switch held in the GPR Only position. If an audio GPR alert is triggered sprinkle water over the site, wait an appropriate time for the moisture to penetrate to depth and repeat the sweep. Repeat this cycle until audio GPR alerts are no longer activated. At this point take a reading with the DGIS. The calculated dielectric constant will be that of the landmine. Raise the landmine so that the top of the mine is a few centimeters above the surface of the sand. Sweep the PSS-14 over the raised landmine. A GPR audio alert will be activated. The response captured by the oscilloscope will be the GPRAP response.

Utility of GPRAP Length Sections to Distinguish Mines from Clutter

The exciting aspect of this research is the discovery of the "Generally Repeatable Audio Response Packet", which we believe might significantly advance the means for discrimination of land mines from clutter in field applications. With further study of a broad variety of land mines, buried in a broad variety of soil settings, field classification of landmine type is entirely possible. Moreover, from a comprehensive response study with typical objects of clutter, significant progress can be achieved in the realm of discrimination.

Future Transfer of the GPRAP Method to Field Applications

Application of our findings to a field environment will require a procedure to be developed that essentially replicates the mine/clutter discrimination tool under development in the laboratory. Because the GPRAP length method relies upon multiple off-axis sweeps, a field procedure would have to be developed to produce the same type of data for the hand-held PSS-14.

In the field, the off-axis position would be the sweep offset from the firing pin. The search for the firing pin would be performed in much the same way as it is for hand-held sweeps, except the operator would be guided to an exact location by means of a Pocket PC (with data acquisition faculties and graphics) that analyzes the MD audio channel and graphically guides the operator to the exact location. Once there the envelope of the maximum MD response would be determined.

Following the determination of the MD envelope, a large number of sweeps would be made, in any direction, at multiple distances from the firing pin. The combined MD+GPR audio output would have to be separated into distinct signals so that the current MD amplitude envelope could be measured and compared to the envelope of maximum MD response previously measured. By this comparison the offset from the firing pin can be estimated. For each sweep the GPRAP length will also be measured and recorded, together with the offset distance, as an offset-length pair. GPRAP data acquired for a broad range of redundant random offsets will statistically produce the same type of data set as was produced in the laboratory.

The statistical GPRAP Length Section, similar to that of Figure 7, will be analyzed by software, resident in the Pocket PC, for the production of geometric information relative to size and shape of the scattering target. This information will be conveyed graphically on the Pocket PC. The section will also be automatically compared to previous recorded sections confirmed as landmines. Software logic on the Pocket PC would convey the decision to the operator as to mine, clutter, or uncertainty graphically. An outwardly simple, but internally complex, device is envisioned.

Appendix A1

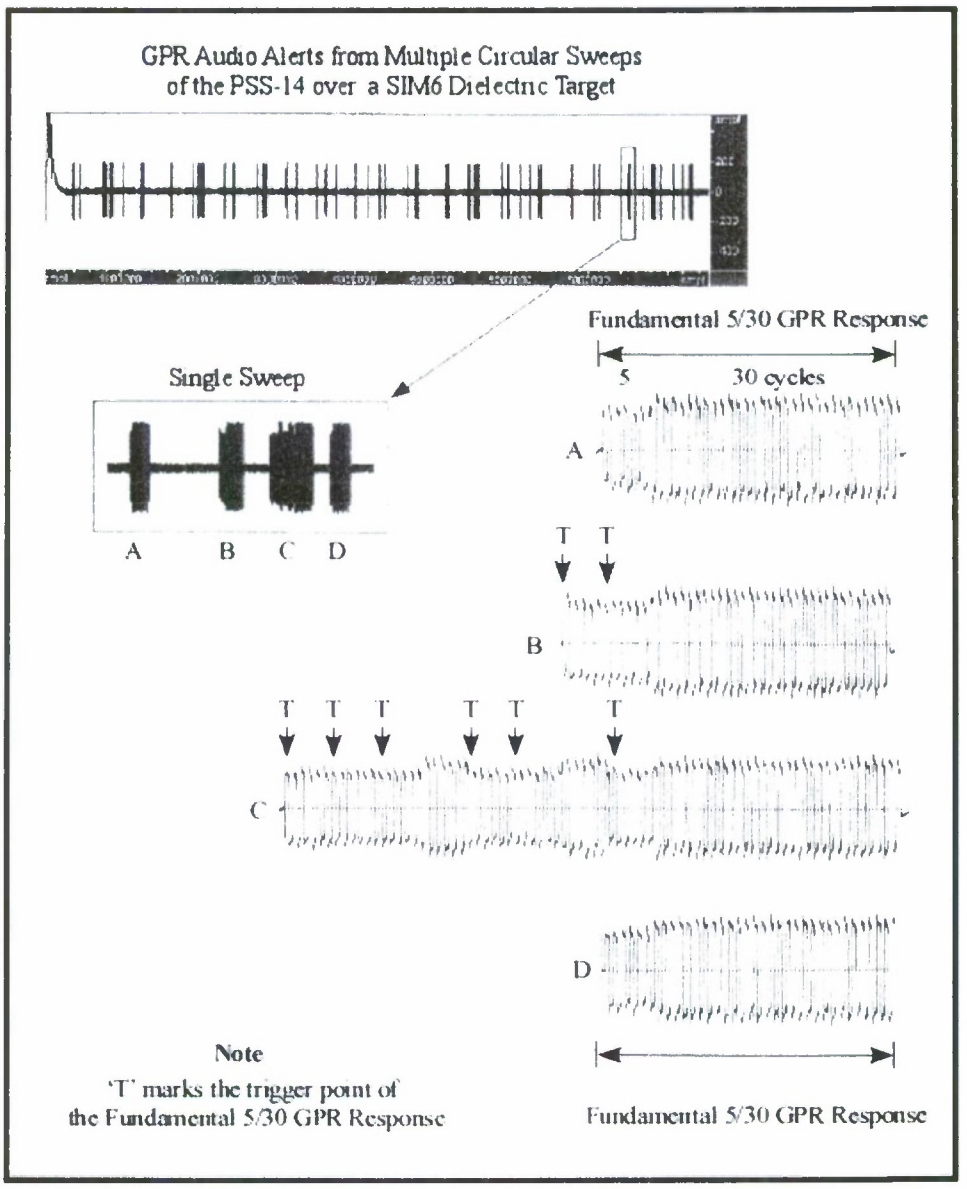


Figure A1. Anatomy of a typical GPR composite response sequence from multiple GPR triggers.

Appendix A2

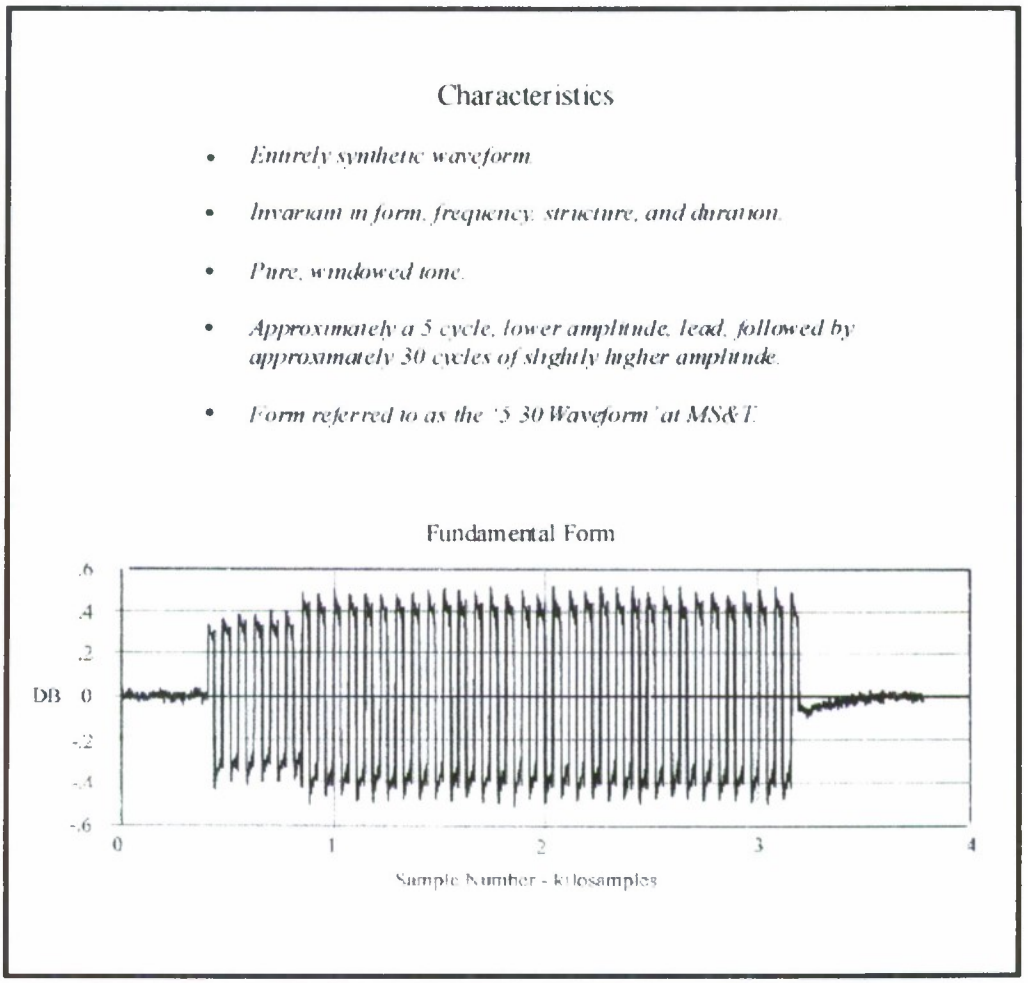


Figure A2. Characteristics of the PSS-14, Software Version 4.02, GPR "Fundamental Form".

Appendix A3

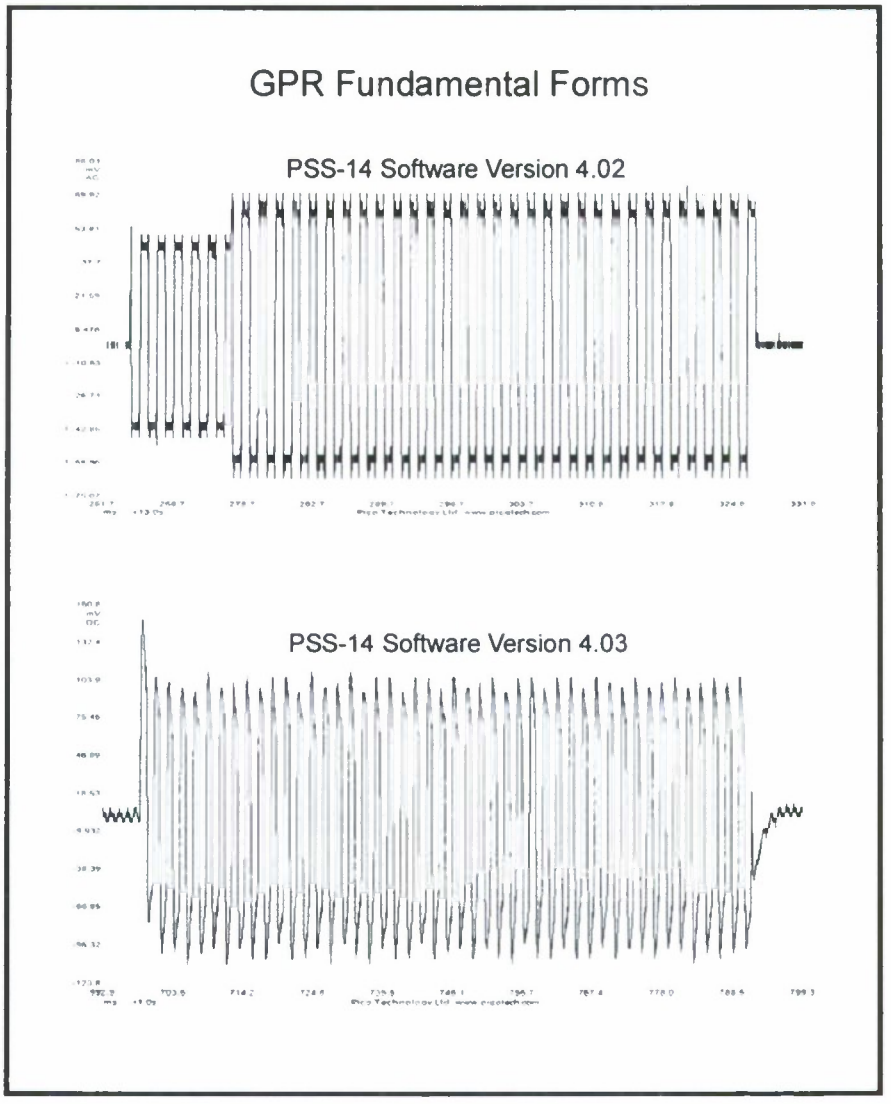


Figure A3. Comparison of PSS-14 GPR Fundamental Forms for HSTAMIDS System Software Versions 4.02 and 4.03

Appendix B

HSTAMIDS
Planar Logarithmic Spiral Antennas

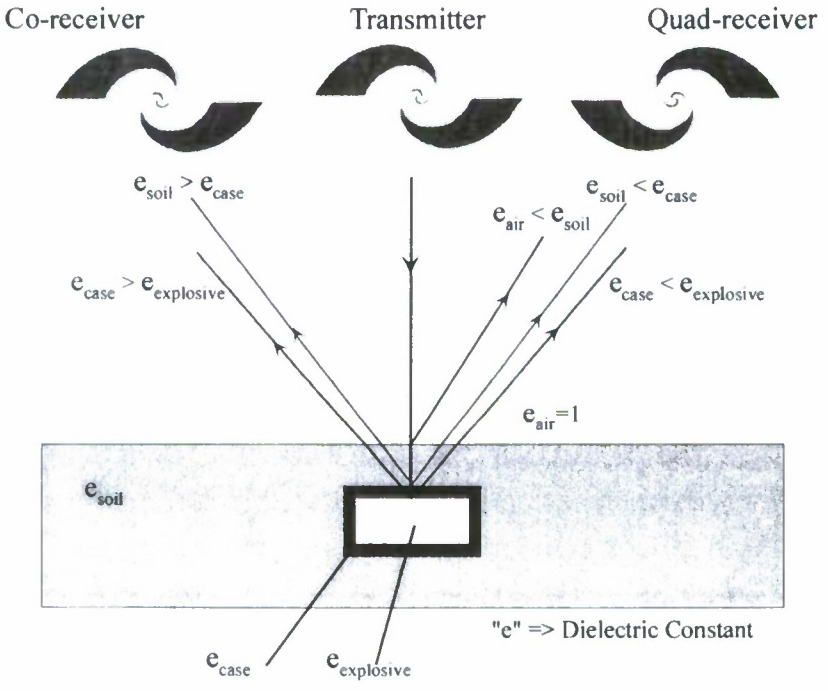


Diagram of co-polarity and quad-polarity of the receiver antennas, relative to the transmission antenna. Note that the co-receiver only senses reflections from interfaces across which the dielectric contrast decreases with depth. The converse is true for the quad-receiver. Transmission field components, across any boundary, always retain the polarity of the incident wave component.

Progress Report of WF911NF-07-2-0053 Grant Activity

August 1, 2007-January 31, 2009

Submitted by:

Dr. Abdoulaye Bah, Principal Investigator
Lincoln University
Jefferson City, Missouri

Final Report August 2007-January 2009
Cooperative Agreement W911NF-07-2-0053

Lincoln University of Missouri completed its third year of funding from the Army Research Lab (ARL). Research has been focused on improving the Army's approach, training and delivery of services in regards to suicide prevention under the direction of Dr. Abdoulaye Bah, principal investigator. This has involved the collection of information on suicide, looking specifically at the variances in suicidal ideation and completed suicides among various ethnic groups; a critique of current policies, procedures and support services utilized by the Army as it pertains to the mental health of enlisted Soldiers and their families; and, comparative research on instruments currently used to measure suicidal ideation. Additionally, the information gleaned from the aforementioned research was intended to be integrated into surveys constructed by team members to be distributed to both Soldiers and professionals that serve them and their families. However, as reported below, this portion of the project was not completed. Due to circumstances beyond our control, clearance issues have prevented the dissemination of the surveys to Soldiers and professional staff. [1] Another task was the configuration of the distance education laboratory in 222 Founders Hall that was completed in collaboration with Polycom.

Under the direction of our cooperative agreement manager, Dr. Madeline Swann, we developed a training video and facilitator's guide that have been distributed throughout the U.S. Army for mandatory viewing under the first phase of a stand down ordered by the Department of the Army in 2009. Those two (2) products are the tangible deliverables of task five (5) of the above mentioned cooperative agreement. Below is a timeline of activities engaged in by the research team during the life of this project.

[1] Attached as an appendix to this report are references to the internal routing of the surveys that were cleared for circulation and administration by Lincoln University's Internal Review Board.

The Center for Suicide Prevention Research and Studies participated in the following activities during the 2007-2008 academic year:

August 6, 2007

Wilson attended the Suicide Prevention Resource Center (SPRC) site visit meeting at DMH. Along with Joan Masters of Partners in Prevention at University of Missouri-Columbia and Jason Hoffmeyer at Linn State, Wilson presented an overview of projects currently in place.

August 7-8, 2007

Wilson attended the 13.0 hour SPRC Suicide Prevention: Community Core Competencies Course. The purpose of this course was to train attendees to be effective in developing and implementing a suicide prevention program in their respective communities. The formation of the program adhered to the social ecological model, including the individual, relationship to peers and/or family, community and society at large.

August 7-10, 2007

Bah, Bardot, Malfatti-Rachell, Rooney and Saha attended the 10th Annual Force Health Protection Conference in Louisville, KY. Bah, along with CAM Madeline Swann, made a presentation about the collaborative efforts between Army Research Laboratory (ARL) and LU.

August 9, 2007

Wilson, along with Perkins of DMH, appeared on the JCTV program *Mental Images* to discuss the prevalence of suicide, suicide prevention and to promote the upcoming 2007 Advancing Suicide Prevention in Missouri conference.

August 21, 2007

Bah and Wilson met with the Region 3 Suicide Prevention Council. This Council has been established by Pathways, according to the eight (8) SPRC regions around the state. Karen Farris, Suicide Prevention Coordinator of Pathways, is the Chair.

August 22, 2007

Conference call between WILL Interactive and the Center. Kickoff meeting for development of *Beyond the Front* (*BTF*).

Aug. 22, 2007 –present

E-mail and telephone communication between WILL Interactive, Fatkin and Bah concerning the development of the storyline for the third year deliverable.

August 28, 2007

Conference call meeting between Swann, Bah, Holland and Wilson regarding the script writing team.

September 9, 2007 (Jefferson City, MO)

Meeting concerning third year deliverable for the grant. In attendance: LU- Bah, Fatkin, Holland, Malfatti-Rachell, Saha, Sampson, Wilson; WILL Interactive- Lyn McCall, Sharon Sloane, Jeff Hall; ARL- Swann; Pentagon- Walter Morales; CHPPM- Boyd, Cartwright, Forys, Waltermyer.

September- mid-December 2007

Script development of character plot and summary; development of script; development of resiliency component; development of Lincoln University Life Preservation Model. These tasks were accomplished by Bah, Wilson and Fatkin.

October 2007

Meeting with other team members to review completed script for feedback.

December 2007

Production of interactive movie and program content recommendation, character plot and summary completed and agreed upon by Lincoln University, ARL and WILL Interactive, Inc.

January- March 2008

Filming of video at the following locations: Washington, D.C., Aberdeen Proving Ground, MD, Potomac, MD and Ft. Polk, LA. Bi-weekly videoconferencing with Stezin of WILL, Inc., Fatkin, Wilson and Bah to review movie scenarios and suggestions for correction.

Late March 2008

The rest of the Lincoln team participated in the viewing of the alpha version of *BTF*.

April 2008

Abdoulaye Bah, Michael Bardot, Mansour Hatef, Antonio Holland, Walter 'Cal' Johnson, Gabrielle Malfatti-Rachell, James Rooney and Gouranga Saha attended the 2008 Military Suicide Prevention Conference held in San Diego, CA. Swann and Fatkin presented *BTF* during a breakout session.

April-May 2008

Incorporation of alpha review comments and development of beta version of *BTF*.

May 2008

Development of *BTF* DVD cover with input received from LU, ARL, WILL,USCHPPM and G-1.

July-August 2008

Completion of task five (5) of the above mentioned cooperative agreement. Release of *BTF* to ARL/G-1.Development of life preservation training course by

Bah, Wilson and Fatkin in collaboration with Idea Works, Inc.

September 2008

Request for development of trainer's guide by the Suicide Prevention Office of the G-1.

October 2008

Official presentation of BTF made at AUSA conference, the largest Army conference attended by over 7,000 people.

October-December 2008

Development of facilitator's guide by Bah, Wilson, Fatkin, Stezin, Swann and Morales.

January 31, 2009

Facilitator's officially approved by the G-1. Completion of amended task five (5).

Appendix

Attached are references to the internal routing of the surveys that were cleared for circulation and administration by Lincoln University's Internal Review Board.

LINCOLN UNIVERSITY OF MISSOURI

☐Sponsored Research ☐ Departmental Research

INFORMATION FOR REVIEW OF A PROJECT INVOLVING HUMAN SUBJECTS

PART A

TO: HUMAN SUBJECTS COMMITTEE	PROJECT TITLE Inventory of Support Services for U.S. Army Soldiers and Families	PROPOSAL NUMBER
1. PROJECT DIRECTOR (Leading Scientist) Joy Sampson	TITLE Associate Professor of Sociology and Social Work	
2. COLLEGE OR DIVISION Liberal Arts, Education and Journalism		PHONE NUMBER 573-681-5152
DEPARTMENT Social and Behavioral Sciences	DEPARTMENT ADDRESS 312 Founders Hall	
3. CO-INVESTIGATORS	TITLE	DEPARTMENT
4. NAME OF SPONSOR (IF NONE, SO STATE) none		
5. IDENTIFY SOURCE OF FUNDS, IF ANY (IF NONE, SO STATE) Army Research Laboratory		
6. NAME OF GRANTEE Lincoln University		

PART B

1. SUMMARY OF PROJECT

Assessment surveys will be distributed to each Army installation in the United States for the purpose of gathering information on suicide prevention, intervention techniques and family support programs currently implemented.

2. NUMBER OF SUBJECTS TO BE USED IN THE PROJECT 100+ (no more than 110)

3. WILL ANY OF THE FOLLOWING BE SUBJECTS?

MINORS? ☐YES ☒NO AGE 18 and over
PREGNANT WOMEN? ☐YES ☒NO
WOMEN OF CHILD-BEARING AGE? ☒YES ☐NO
INSTITUTIONALIZED PERSONS? ☐YES ☒NO
INCOMPETENT PERSONS? ☐YES ☒NO
STUDENTS? ☐YES ☒NO
LOW INCOME PERSON? ☒YES ☐NO
MINORITIES? ☒YES ☐NO

4. STATE WHY SUBJECTS IN ITEM B-3 ARE REQUIRED

This survey will assess the efficacy of family support services by surveying Army personnel that administer these services. Because the Army is diverse in its composition, some of the respondents may fall within the categories listed in question 3.

5. STATE DURATION OF PARTICIPATION OF SUBJECTS 30 – 45 minutes

6. STATE IN OUTLINE FORM WHAT WILL BE DONE TO RESEARCH SUBJECTS, USE FLOW CHARTS WHEN APPLICABLE

n/a

7. IF BLOOD WILL BE COLLECTED, STATE METHOD AND TOTAL QUANTITY

n/a

8. IDENTIFY DRUGS, APPLIANCES OR PROCEDURES THAT ARE EXPERIMENTAL OR THAT ARE CLASSED AS INVESTIGATIONAL BY FDA

n/a

9. IDENTIFY FACTORS IN ITEMS 6 AND 8 THAT IMPOSE RISK. DEFINE THE RISK

n/a

10. DESCRIBE PROCEDURES FOR PROTECTING AGAINST OR MINIMIZING RISK. ASSESS THEIR POTENTIAL EFFECTIVENESS

n/a

11. IDENTIFY BENEFITS (PERSONAL, SOCIAL, SCIENTIFIC, ETC.)

A thorough assessment of suicide intervention practices, policies and family support services used at military installations in the United States.

12. STATE METHODS USED TO INSURE CONFIDENTIALITY

No identifying information will be requested from the respondents. All surveys will be numbered for compiling statistical analysis using SPSS software.

13. ATTACH COPY OF PROPOSED CONSENT DOCUMENTATION

DATE	SIGNATURE OF PROJECT DIRECTOR

VOLUNTEER AGREEMENT OF INFORMED CONSENT

The proponent for this research is:	**Lincoln University** **820 Chestnut Street** **Jefferson City, MO 65101**

Authority:	Privacy Act of 1974, 10 U.S.C. 3013, for research and development: The head of each agency shall make and preserve records containing adequate and proper documentation of the organization, functions, policies, decisions, procedures, and essential transactions of the agency and designed to furnish the information necessary to protect the legal and financial rights of the agency and of persons directly affected by the agency's activities.
Principal purpose:	To document voluntary participation in the Research program.
Routine Uses:	The SSN and home address will be used for identification and locating purposes. Information derived from the project will be used for documentation, adjudication of claims, and mandatory reporting of medical conditions as required by law. Information may be furnished to Federal, State, and local agencies.
Disclosure:	The furnishing of your SSN and home address is mandatory and necessary to provide identification and to contact you if future information indicates that your health may be adversely affected. Failure to provide the information may preclude your voluntary participation in this data collection.

Part A • Volunteer agreement for subjects in approved Lincoln University research projects

Title of Research Project:	Inventory of Support Services for U.S. Army Soldiers and Families	
Human Use Protocol Log #		
Principal Investigator:	Joy Sampson Associate Professor of Sociology 312 Founders Hall	Phone: (573) 681-5152 E-Mail: sampsonj@lincolnu.edu
Location of Research:	Various military installations throughout the U.S.	
Dates of Participation:	1 June 2007 – 30 September 2007	

Part B • To be completed by the Principal Investigator

Purpose of the Research

You are being asked to volunteer in a research project that will evaluate the efficacy of family support services offered at installations throughout the United States to Soldiers and their families. This research project involves gathering data through the attached survey. Your responses will be used to help the U.S. Army evaluate their current family support services, including suicide prevention efforts.

Procedures

You will be asked to complete a confidential survey related to family support services and suicide prevention offered at installations. The survey will take approximately 30-45 minutes of your time.

Your responses on this survey will provide information needed to improve the delivery of family support services offered at installations as well as target specific areas within support services that need to be expanded.
If you agree to participate in this study, you will be asked to sign this Volunteer Agreement. You must be at least 18 years of age to participate.

Benefits

The findings of this study will help the U.S. Army evaluate family support services and suicide prevention efforts currently implemented at installations by identifying strengths and weaknesses in the accessibility and usage. This will in turn guide the Army in the creation and implementation of future or revised family support services.

Risks

The risks that may be encountered in this study are minimal and typical of the everyday risks encountered by military and civilian personnel performing office duties. If you have any concerns during the completion of this survey, please inform the investigators immediately. You may be told to stop your activity until the problems are resolved.

Confidentiality

All data and information obtained about you will be considered privileged and held in confidence. Your responses will be recorded using a neutral code number to ensure that your name will not be associated with the data shared in reports or publications. Your consent form will be placed in a locked cabinet by the Principal Investigator. In order to ensure that your responses will not be identified in any report or revealed to anyone, each form will be reviewed upon receipt by one of the survey administrators. If any identifying information appears on the survey (such as name, social security number, etc.), the investigators will delete the information and will replace it with a neutral code number.

Disposition of Volunteer Agreement

The Principal Investigator will retain the original signed Volunteer Agreement and forward a photocopy of it to the Chair of the Institutional Review Board after the data collection. The Principal Investigator or survey administrator will provide a copy of the signed and initialed Volunteer Agreement to you.

Contacts for Additional Assistance

If you have questions concerning your rights on research-related injury, or if you have any complaints about your treatment while participating in this research, you can contact:

Chair, Institutional Review Board
Attn: Jerry Vandertuig, Professor
Lincoln University
820 Chestnut Street, Jefferson City, MO
65101
(573) 681-5382

Informed Consent

I do hereby volunteer to participate in the research project described in this document. I have full capacity to consent and have attained my 18th birthday. The implications of my voluntary participation, duration, and purpose of the research project, the methods and means by which it is to be conducted, and the inconveniences and hazards that may reasonably be expected have been explained to me. I have been given an opportunity to ask questions concerning this research project. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights or project related injury, I may contact the **Lincoln University Institutional Review Board Chairperson at Jefferson City, Missouri, USA, by telephone at 573-681-5382 or the Principal Investigator, Joy Sampson, at 573-681-5152.**

I understand that any published data will not reveal my identity. If I choose not to participate, or later wish to withdraw from any portion of it, I may do so without penalty. I understand that military personnel are not subject to punishment under the Uniform Code of Military Justice for choosing not to take part as human volunteers and that no administrative sanctions can be given me for choosing not to participate. I may at any time during the course of the project revoke my consent and withdraw without penalty or loss of benefits. However, I may be required (military volunteer) or requested (civilian volunteer) to undergo certain examinations if, in the opinion of an attending physician, such examinations are necessary for my health and well being.

Printed Name Of Volunteer *(First, MI., Last)*	
Social Security Number (SSN)	***Permanent Address Of Volunteer***
Date Of Birth *(Month, Day, Year)*	
Today's Date *(Month, Day, Year)*	***Signature Of Volunteer***
Signature Of Administrator	

Survey

Support Services for U.S. Army Soldiers and Families

Name of installation:_____

City/State: _____

Support Services

1. Listed below are programs and services provided for Army enlisted Soldiers and their families to improve their quality of life, including physical and mental health well-being. Please indicate the services/programs on your installation.

	yes	no	unknown
Army Red Cross Emergency			
Army Emergency Relief			
Army Family Action			
Employment Readiness Program			
Family Advocacy			
Family Assistance Center			
Information, Referral and Follow-up Program			
Family Life Center			
Chaplain's Support Services			
Crisis Intervention Hotline			
Social Work Service			
Suicide Prevention Services			
On-Site Medical Support Services			
Tri-Care			
Army Substance Abuse Program			
Casualty Assistance Programs			
Victim Advocacy			
Psychiatrist/Psychologist Counseling			
Mental Health Screening Services			
Health Risk Assessments			
In-patient hospitalization			
Others, please indicate:			

2. Which of the above services are primarily used to support suicide prevention to Soldiers? Please cite.

3. Which of the above services are primarily used to support suicide prevention to families? Please cite.

4. Are there support groups on your installation for enlisted Soldiers?

Type of Support	yes	no	unknown
Caregiver support groups			
Family member support groups			
Suicide prevention support groups			
Chaplain's support group			
Other, please cite:			

5. Are there support groups on your installation for the families of enlisted Soldiers?

Type of Support	yes	no	unknown
Caregiver support groups			
Family member support groups			
Suicide prevention support groups			
Chaplain's support group			
Other, please cite:			

Participation Ratio

6. During the past year, how many families (spouses and children) received counseling for suicidal ideation and/or suicide attempts at your installation?

	Spouses	Children	Total
Ideation	_____	_____	____
Attempts	_____	_____	____

7. During the past year, how many Soldiers received counseling for suicidal ideation and/or suicide attempts at your installation?

Ideation	Attempts	Total
_____	_____	____

8. Are any of the following perceived as barriers to spousal/children's participation in Family Support Services?

	yes	no
Time not convenient	____	____
Location(s) of services not convenient	____	____
Lack of transportation	____	____
Families are unaware of services	____	____
Services not available to meet needs	____	____
Financial barriers	____	____
Embarrassment, shame	____	____
Not comfortable using services	____	____

Others, please cite:

_____
_____
_____
_____
_____

9. Are any of the following perceived as barriers to Soldier participation in Family Support Services? (please cite the top three)

	yes	no
Embarrassment, shame	____	____
Services not available to meet needs	____	____
Time not convenient	____	____
Not comfortable using services	____	____
Fear of unit reaction	____	____

Others, please cite:

_____
_____
_____
_____

10. How many staff members are available to provide mental health services to enlisted Soldiers?

_____

11. Briefly describe the protocol used to provide support services to enlisted Soldiers who are experiencing suicide crisis.

12. Briefly describe the protocol used to provide support services to family members of enlisted Soldiers experiencing a suicide crisis.

13. Are there civilian agency services used to support enlisted Soldiers' mental health needs for suicide prevention?

Yes___ No___

If yes, please list the services.

14. How many enlisted Soldiers have been referred to civilian agency services for mental health counseling and suicide prevention during the past year?

Mental health counseling____ Suicide prevention___

15. Do you have difficulty referring enlisted Soldiers for mental health support and suicide prevention?

no____ yes___ because of:

geographical location	_____
insufficient services	_____
waiting lists	_____
level of satisfaction with local providers of services	_____

other access issues _____

If you selected "yes" in any of the spaces above, please give specific details about the problems faced in your area.

Professional Training

16. What training areas are most useful for enhancing clinical practice in Army suicide prevention?

____ Diagnosis and treatment modalities
____ Managing Soldiers with on-going risk for suicide
____ Developing safety and management plans
____ Conducting a risk assessment
____ Understanding legal and ethical issues related to suicide
____ Attitudes and approach for working with suicidal Soldiers
____ Other, please cite:

17. What education or training experiences would you seek to improve quality of services provided to Soldiers at your installation?

____ Brief workshops
____ In-service training conducted by Army installation
____ On-line suicide prevention training
____ Degree program at a University
____ Certification programs
____ Conferences
____ Other, please cite:

18. Which are most important when considering attending education/training programs on suicide prevention?

____ Cost
____ Location
____ Perceived benefits
____ CEU requirements
____ Convenience
____ Content of training
____ Skills and experience of presenter
____ Particular topic
____ Peer interaction
____ Time away from office
____ Other, please cite:

19. Has your Army installation targeted who should be trained for suicide intervention/prevention? ____ Yes____ No

Where would you train Soldiers? _____
Who would train them? _____

20. Does your Army installation have a suicide prevention task force or work group that meets regularly to discuss, plan and execute "next step" efforts to reduce suicide risk? ____ Yes ____ No

If yes, please briefly describe the plan.

INFORMATION FOR REVIEW OF A PROJECT INVOLVING HUMAN SUBJECTS

PART A

TO: HUMAN SUBJECTS COMMITTEE	PROJECT TITLE SUICIDE PREVENTION – USER FOCUSED EVALUATION	PROPOSAL NUMBER
1. PROJECT DIRECTOR (Leading Scientist) GABRIELLE MALFATTI-RACHELL	TITLE ASSISTANT PROFESSOR	
2. COLLEGE OR DIVISION LIBERAL ARTS, EDUCATION AND JOURNALISM		PHONE NUMBER 681-5232
DEPARTMENT LANGUAGES, LITERATURE AND PHILOSOPHY	DEPARTMENT ADDRESS 431 MARTIN LUTHER KING HALL	
3. CO-INVESTIGATORS	TITLE	DEPARTMENT

4. NAME OF SPONSOR (IF NONE, SO STATE)
ARMY RESEARCH LAB (ARL)

5. IDENTIFY SOURCE OF FUNDS, IF ANY (IF NONE, SO STATE)
ARL Grant

6. NAME OF GRANTEE
Lincoln University of Missouri

PART B

1. SUMMARY OF PROJECT

User focused evaluation of current suicide prevention programs in the army to evaluate the self perceived ability of soldiers to intervene Effectively in situations that can potentially lead to suicide.

2. NUMBER OF SUBJECTS TO BE USED IN THE PROJECT to be established by the US Army

3. WILL ANY OF THE FOLLOWING BE SUBJECTS?

MINORS? ☐YES ☒NO AGE 18 and over
PREGNANT WOMEN? ☐YES ☒NO
WOMEN OF CHILD-BEARING AGE? ☒YES ☐NO
INSTITUTIONALIZED PERSONS? ☐YES ☒NO
INCOMPETENT PERSONS? ☐YES ☒NO
STUDENTS? ☐YES ☒NO
LOW INCOME PERSON? ☒YES ☐NO
MINORITIES? ☒YES ☐NO

4. STATE WHY SUBJECTS IN ITEM B-3 ARE REQUIRED

This evaluation seeks to learn of the perceptions held by a cross sample of Army personnel. Because the Army is one of the most diverse Institutions in our country, it stands to reason that some of the participants will fall under some of the B3 categories.

5. STATE DURATION OF PARTICIPATION OF SUBJECTS Completion of the survey will require about 30 minutes. If participants agree to be further interviewed, interviews will last between 45 and 60 minutes.

6. STATE IN OUTLINE FORM WHAT WILL BE DONE TO RESEARCH SUBJECTS, USE FLOW CHARTS WHEN APPLICABLE
-subjects will be identified
-subjects will complete the survey
-some subjects may be contacted for follow up
7. IF BLOOD WILL BE COLLECTED, STATE METHOD AND TOTAL QUANTITY
n/a
8. IDENTIFY DRUGS, APPLIANCES OR PROCEDURES THAT ARE EXPERIMENTAL OR THAT ARE CLASSED AS INVESTIGATIONAL BY FDA
n/a
9. IDENTIFY FACTORS IN ITEMS 6 AND 8 THAT IMPOSE RISK. DEFINE THE RISK
n/a
10. DESCRIBE PROCEDURES FOR PROTECTING AGAINST OR MINIMIZING RISK. ASSESS THEIR POTENTIAL EFFECTIVENESS
n/a
11. IDENTIFY BENEFITS (PERSONAL, SOCIAL, SCIENTIFIC, ETC.)
Because current suicide prevention efforts in the Army are hinged on each Soldier being a "gate keeper" for preventing suicide, it is very
Important to know the individual Soldier's perceived ability to deal with situations that can potentially lead to suicide. This information is
of great relevance as Lincoln University prepares to develop a new training module in collaboration with the Army for future use.
12. STATE METHODS USED TO INSURE CONFIDENTIALITY
Once data is collected, the names of participants will be removed from all data collection forms and numbers will be assigned to identify
respondents. This process will be conducted by the lead researcher.
13. ATTACH COPY OF PROPOSED CONSENT DOCUMENTATION

DATE May 16, 2007	SIGNATURE OF PROJECT DIRECTOR

VOLUNTEER AGREEMENT OF INFORMED CONSENT

The proponent for this research is:	**Lincoln University** **820 Chestnut Street** **Jefferson City, MO 65101**

Authority:	Privacy Act of 1974, 10 U.S.C. 3013, for research and development: The head of each agency shall make and preserve records containing adequate and proper documentation of the organization, functions, policies, decisions, procedures, and essential transactions of the agency and designed to furnish the information necessary to protect the legal and financial rights of the agency and of persons directly affected by the agency's activities.
Principal purpose:	To document voluntary participation in the Research program.
Routine Uses:	The SSN and home address will be used for identification and locating purposes. Information derived from the project will be used for documentation, adjudication of claims, and mandatory reporting of medical conditions as required by law. Information may be furnished to Federal, State, and local agencies.
Disclosure:	The furnishing of your SSN and home address is mandatory and necessary to provide identification and to contact you if future information indicates that your health may be adversely affected. Failure to provide the information may preclude your voluntary participation in this data collection.

Part A • Volunteer agreement for subjects in approved Lincoln University research projects

Title of Research Project:	User-Focused Evaluation of Army Suicide Prevention Models	
Human Use Protocol Log #		
Principal Investigator:	Gabrielle Malfatti-Rachell Assistant Professor of Spanish and Latin American Studies 418 Martin Luther King Hall	Phone: (573) 681-5232 E-Mail: rachellg@lincolnu.edu
Location of Research:	Various military installations throughout the U.S.	
Dates of Participation:	1 June 2007 – 31 December 2007	

Part B • To be completed by the Principal Investigator

Purpose of the Research

You are being asked to volunteer in a research project that will evaluate the perceived confidence of Soldiers when confronted with a suicidal situation. This research project involves gathering data through the attached survey. Your responses will be used to help the U.S. Army evaluate their current suicide prevention efforts.

Procedures

You will be asked to complete a confidential survey related to suicide prevention in the Army. The survey will take approximately 30-45 minutes of your time. At the end of the survey, you will have the option to volunteer to be contacted later for the purpose of clarifying some of your responses.

Your responses on this survey will provide information needed to facilitate improvements in the way the Army prevents the occurrence of suicide among its Soldiers. In order to improve on current programs, we must understand how Soldiers rate their own effectiveness in identifying suicidal behaviors, risk factors and protective factors in themselves and others. This evaluation is based on the guidelines provided by the LivingWorks Suicide Intervention Handbook (a companion to the Applied Suicide Intervention Skills Training program) and the USACHPPM Suicide Prevention Manual.

If you agree to participate in this study, you will be asked to sign this Volunteer Agreement. You must be at least 18 years of age to participate.

Benefits

The findings of this study will help the U.S. Army evaluate the currently used suicide prevention efforts by identifying strengths and weaknesses in the individual Soldier's ability to deal with suicide. This will in turn guide the Army in the creation and implementation of future or revised suicide prevention models.

Risks

The risks that may be encountered in this study are minimal and typical of the everyday risks encountered by military and civilian personnel performing office duties. If you have any concerns during the completion of this survey, please inform the investigators immediately. You may be told to stop your activity until the problems are resolved.

Confidentiality

All data and information obtained about you will be considered privileged and held in confidence. Your responses will be recorded using a neutral code number to ensure that your name will not be associated with the data shared in reports or publications. Your consent form will be placed in a locked cabinet by the Principal Investigator. In order to ensure that your responses will not be identified in any report or revealed to anyone, each form will be reviewed upon receipt by one of the survey administrators. If any identifying information appears on the survey (such as name, social security number, etc.), the investigators will delete the information and will replace it with a neutral code number.

Disposition of Volunteer Agreement

The Principal Investigator will retain the original signed Volunteer Agreement and forward a photocopy of it to the Chair of the Institutional Review Board after the data collection. The Principal Investigator or survey administrator will provide a copy of the signed and initialed Volunteer Agreement to you.

Contacts for Additional Assistance

If you have questions concerning your rights on research-related injury, or if you have any complaints about your treatment while participating in this research, you can contact:

Chair, Institutional Review Board
Attn: Jerry Vandertuig, Professor
Lincoln University
820 Chestnut Street, Jefferson City, MO 65101
(573) 681-5382

Informed Consent

I do hereby volunteer to participate in the research project described in this document. I have full capacity to consent and have attained my 18th birthday. The implications of my voluntary participation, duration, and purpose of the research project, the methods and means by which it is to be conducted, and the inconveniences and hazards that may reasonably be expected have been explained to me. I have been given an opportunity to ask questions concerning this research project. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights or project related injury, I may contact the **Lincoln University Institutional Review Board Chairperson at Jefferson City, Missouri, USA, by telephone at 573-681-5382 or the Principal Investigator, Gabrielle Malfatti-Rachell, at 573-681-5232.**
I understand that any published data will not reveal my identity. If I choose not to participate, or later wish to withdraw from any portion of it, I may do so without penalty. I understand that military personnel are not subject to punishment under the Uniform Code of Military Justice for choosing not to take part as human volunteers and that no administrative sanctions can be given me for choosing not to participate. I may at any time during the course of the project revoke my consent and withdraw without penalty or loss of benefits. However, I may be required (military volunteer) or requested (civilian volunteer) to undergo certain examinations if, in the opinion of an attending physician, such examinations are necessary for my health and well being.

Printed Name Of Volunteer *(First, MI., Last)*	
Social Security Number (SSN)	***Permanent Address Of Volunteer***
Date Of Birth *(Month, Day, Year)*	
Today's Date *(Month, Day, Year)*	***Signature Of Volunteer***
Signature Of Administrator	

The following survey is part of a Utilization Focused Evaluation (UFE) of suicide prevention efforts currently employed by the United States Army. Utilization Focused Evaluation differs from other types of program evaluation in that it centers its efforts in collecting feedback from those individuals most closely impacted by the success or failure of the program.

Suicide prevention programs in the U.S. Army depend greatly on the ability of each individual Soldier to recognize suicide risk patterns in him/herself and others, and pursuit appropriate avenues for intervention. This survey seeks to enhance our understanding of Soldiers' perception of their own abilities to (a) recognize suicidal risk factors; (b) recognize and utilize protective factors; and (c) seek help for themselves and/or others.

USER-FOCUSED EVALUATION SURVEY

About the respondent

Gender Male ☐ Female ☐

Race or ethnicity _____

Age _____

Rank _____

Stationed at _____

Time with the Army _____

Total time spent in active duty _____

Total time spent in a conflict zone _____

Which of the following personal factors do you consider to be most protective against suicide and self-harming behaviors (mark all that apply):

Personal Factors	For myself	For others
Easy temperament	☐	☐
Previous experience with crisis resolution	☐	☐
Optimistic outlook	☐	☐
Social/emotional competence	☐	☐
High self esteem/ self worth	☐	☐
Decision making/ problem solving skills	☐	☐
Sense of personal control	☐	☐
Sense of belonging to a group/organization	☐	☐
High and realistic expectations	☐	☐
High spiritual resiliency	☐	☐

Which of the following Environmental factors do you consider to be most protective against suicide and self-harming behaviors (mark all that apply):

Environmental Factors	For myself	For others
Strong family relationships	☐	☐
Models of healthy coping	☐	☐
Encouragement of participation	☐	☐
Opportunities to make significant contributions	☐	☐
Available social supports	☐	☐
Available helping resources	☐	☐
Healthy spiritual/religious affiliation	☐	☐
Cultural and religious beliefs against suicide	☐	☐

Which of the following Army support services have you/would you utilize in time of personal crisis:

Army Support Services	Have utilized	Would utilize
Combat Stress Control Teams	☐	☐
Family Support Groups	☐	☐
Family Life Centers	☐	☐
Family Advocacy Program	☐	☐
Community Counseling Services	☐	☐
Army Emergency Relief	☐	☐
Community Mental Health	☐	☐
Army Chaplaincy	☐	☐

It is the responsibility of Army leadership from the top commander to platoon and squad leaders to promote the safety of all military personnel. I feel that my leaders…

Foster mutual "Buddy Care" among all military personnel

All of the time ☐ Most of the time☐ Seldom☐ Almost never ☐

Pay attention to warning signs and respond to those who need help

All of the time ☐ Most of the time☐ Seldom☐ Almost never ☐

Are aware that heightened stress, relationship problems, and impending holidays can trigger inappropriate coping behaviors on vulnerable individuals

All of the time ☐ Most of the time☐ Seldom☐ Almost never ☐

Communicate in words and actions that it is not only acceptable, but a sign of strength, to recognize life problems and get help to deal with them constructively

All of the time ☐ Most of the time☐ Seldom☐ Almost never ☐

Support and protect to the fullest extent possible people who seek help early, before a crisis develops

All of the time ☐ Most of the time☐ Seldom☐ Almost never ☐

Create a responsive, caring, and responsible environment where individuals are motivated to seek help with personal struggles without fear of being singled out

All of the time ☐ Most of the time☐ Seldom☐ Almost never ☐

Suicide Prevention Training received in the last year

Assist ☐ QPR ☐ Lecture ☐ Video ☐

I would rank the Suicide Prevention Training I received as

Excellent ☐ Good ☐ Adequate ☐ Poor☐ Irrelevant☐

I wish that Suicide Prevention Training would be

The same as it is now ☐ Interactive in a class setting ☐ In video game format☐

Do you feel that the training you are currently receiving in suicide prevention adequately prepares you to intervene in a manner that could save a fellow Soldier's life?

Yes ☐ No☐

Please explain

_____

_____

_____

Is there anything else you would like to share with us about suicide prevention training o other related issues?

_____

_____

_____

May we contact you if we need you to clarify any answers. Please know that even in that event your confidentiality will be protected. If you agree to be contacted, please provide your name and either your AKO or personal e-mail address.

_____

_____

_____

VOLUNTEER AGREEMENT OF INFORMED CONSENT

The proponent for this research is:	**Lincoln University** **820 Chestnut Street** **Jefferson City, MO 65101**

Authority:	Privacy Act of 1974, 10 U.S.C. 3013, for research and development: The head of each agency shall make and preserve records containing adequate and proper documentation of the organization, functions, policies, decisions, procedures, and essential transactions of the agency and designed to furnish the information necessary to protect the legal and financial rights of the agency and of persons directly affected by the agency's activities.
Principal purpose:	To document voluntary participation in the Research program.
Routine Uses:	
Disclosure:	

Part A • Volunteer agreement for subjects in approved Lincoln University research projects

Title of Research Project:	Suicide Prevention for the Army	
Human Use Protocol Log #		
Principal Investigator:	Abdoulaye Bah Associate Professor of Criminal Justice 416 Martin Luther King Hall	Phone: (573) 681-5227 E-Mail: baha@lincolnu.edu
Location of Research:	Various military installations throughout the U.S.	
Dates of Participation:	1 June 2007 – 15 April 2008	

Part B • To be completed by the Principal Investigator

Purpose of the Research

You are being asked to volunteer in a research project that will evaluate the efficacy of suicide prevention services offered to Soldiers at installations throughout the United States. This research project involves gathering data through the attached survey. Your responses will be used to help the U.S. Army evaluate their current suicide prevention strategies.

Procedures

You will be asked to complete a confidential survey related to perceived support from family and friends, attitude assessment and religious beliefs. The survey will take approximately 20 minutes of your time.

Your responses on this survey will provide information needed to improve the delivery of suicide prevention services offered at installations as well as target specific areas within suicide prevention that need to be expanded.
If you agree to participate in this study, you will be asked to sign this Volunteer Agreement. You must be at least 18 years of age to participate.

Benefits

The findings of this study will help the U.S. Army evaluate suicide prevention efforts currently implemented at installations by identifying strengths and weaknesses in its focus and delivery. This will in turn guide the Army in the creation and implementation of future or revised suicide prevention services.

Risks

The risks that may be encountered in this study are minimal and typical of the everyday risks encountered by military and civilian personnel performing office duties. If you have any concerns during the completion of this survey, please inform the investigators immediately. You may be told to stop your activity until the problems are resolved.

Confidentiality

All data and information obtained about you will be considered privileged and held in confidence. Your responses will be recorded using a neutral code number to ensure that your name will not be associated with the data shared in reports or publications. Your consent form will be placed in a locked cabinet by the Principal Investigator. In order to ensure that your responses will not be identified in any report or revealed to anyone, each form will be reviewed upon receipt by one of the survey administrators. If any identifying information appears on the survey (such as name, social security number, etc.), the investigators will delete the information and will replace it with a neutral code number.

Disposition of Volunteer Agreement

The Principal Investigator will retain the original signed Volunteer Agreement and forward a photocopy of it to the Chair of the Institutional Review Board after the data collection. The Principal Investigator or survey administrator will provide a copy of the signed and initialed Volunteer Agreement to you.

Contacts for Additional Assistance

If you have questions concerning your rights on research-related injury, or if you have any complaints about your treatment while participating in this research, you can contact:

Chair, Institutional Review Board

Attn: Jerry Vandertuig, Professor
Lincoln University
820 Chestnut Street, Jefferson City, MO 65101
(573) 681-5382

Informed Consent

I do hereby volunteer to participate in the research project described in this document. I have full capacity to consent and have attained my 18th birthday. The implications of my voluntary participation, duration, and purpose of the research project, the methods and means by which it is to be conducted, and the inconveniences and hazards that may reasonably be expected have been explained to me. I have been given an opportunity to ask questions concerning this research project. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights or project related injury, I may contact the **Lincoln University Institutional Review Board Chairperson at Jefferson City, Missouri, USA, by telephone at 573-681-5382 or the Principal Investigator, Abdoulaye Bah, at 573-681-5227.**

I understand that any published data will not reveal my identity. If I choose not to participate, or later wish to withdraw from any portion of it, I may do so without penalty. I understand that military personnel are not subject to punishment under the Uniform Code of Military Justice for choosing not to take part as human volunteers and that no administrative sanctions can be given me for choosing not to participate. I may at any time during the course of the project revoke my consent and withdraw without penalty or loss of benefits. However, I may be required (military volunteer) or requested (civilian volunteer) to undergo certain examinations if, in the opinion of an attending physician, such examinations are necessary for my health and well being.

Printed Name Of Volunteer *(First, MI., Last)*	
Today's Date *(Month, Day, Year)*	***Signature Of Volunteer***
Signature Of Administrator	

1. What is your race? (circle one)

White-1 African American/Black-2 Hispanic-3 Asiatic/Oriental-4 Other (specify)-5

2. How old are you?

_____

3. What is your gender?

Male 1

Female 2

4. Taking things all together, how would you describe your bond with your family? Would you say that you are strongly bonded, moderately bonded, a little bonded, or not at all bonded?

strongly bonded. 3

moderately bonded. 2

a little bonded. 1

not at all bonded. 8

5. Taking things all together, how would you describe your marriage? Would you say that your marriage

is very happy, pretty happy, or not too happy?

Very happy..... 3

Pretty happy..... 2

Not too happy..... 1

Not applicable..... 8

6. Do you think a person has the right to end his or her own life if this person . . . READ EACH STATEMENT, AND CIRCLE ONE CODE FOR EACH:

	Yes	No	DON'T KNOW
A. Has an incurable disease?	1	2	8
B. Has gone bankrupt?	1	2	8
C. Has dishonored his or her family?	1	2	8
D. Is tired of living and ready to die?	1	2	8

7. Taken all together, how would you say things are these days--would you say that you are very happy, pretty happy, or not too happy?

Very happy 3

Pretty happy 2

Not too happy 1

8. How comfortable are you with talking about your feelings with relatives?

Very comfortable. 3

Fairly comfortable. 2

Not at all comfortable. 1

9. How comfortable are you with talking about your feelings with friends?

Very comfortable. 3

Fairly comfortable. 2
Not at all comfortable. 1

10. If you had a problem and were in need of help, how helpful would your relatives be?
    Very helpful. 3
    Somewhat helpful. 2
    No help at all. 1
11. If you had a problem and were in need of help, how helpful would your friends be?
    Very helpful. 3
    Somewhat helpful. 2
    No help at all. 1
12. What is your religious preference?
    Protestant 1
    Catholic 2
    Jewish 3
    None 4
    OTHER (specify religion and/or church denomination) _____ 5
13. How often do you attend religious services?
    Never 0
    Less than once a year. 1
    About once or twice a year 2
    Several times a year 3
    About once a month 4
    2-3 times a month 5
    Nearly every week 6
    Every week 7
    Several times a week 8
14. Do you believe there is a life after death?
    Yes 1
    No 2
    Undecided 3
15. People have different images of the world and human nature. We would like to know the kinds of images you have.

If you think that *"The world is basically filled with evil and sin,"* you would place yourself at 1. If you think *"There is much goodness in the world which hints at God's goodness"* you would place yourself at 7. If you think things are somewhere in between these two, you would place yourself at 2, 3, 4, 5 or 6.

The world is basically filled with evil and sin. — **There is much goodness in the world which hints at God's goodness.**

1 2 3 4 5 6 7

Thank you for your time and effort.